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ABSTRACT

The most extensive research and development (R&D) into the adult cognitive skills essential for workplace literacy has been conducted by the U.S. military. Military R&D related to workplace literacy has been concentrated in the following areas: formulation of developmental model for literacy in four stages (basic adaptive processes, conscious control and memory, language development, and processing representations); assessment of literacy and other cognitive skills; identification of the literacy demands of jobs based on approaches that included predictive validity and task analysis methods; and development of programs which included the literacy program of World War II, Functional Literacy program (FLIT), Job-Oriented Basic Skills program (JOBS), Job Skills Education Program (JSEP), and Experimental Functional Skills Program (XFSP). Among the major findings of literacy-related R&D conducted by the military are the following: literacy is highly related to measures of intelligence and aptitude; literacy and job performance are continuously related; there is no technical solution to the problem of setting standards for literacy; there is no best method of identifying jobs' literacy demands; and workplace literacy programs can produce significant improvements in job-related reading for only brief periods of time and must be supplemented by continued opportunities for education and learning. (Twenty-six tables/figures are included. Contains 73 references.) (MN)

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NATIONAL CENTER ON ADULT LITERACY

THE MILITARY EXPERIENCE AND WORKPLACE LITERACY:

A REVIEW AND SYNTHESIS FOR POLICY AND PRACTICE

Thomas G. Sticht
Applied Behavioral & Cognitive Sciences, Inc.

NCAL TECHNICAL REPORT TR94-01
MARCH 1995

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UNIVERSITY OF PENNSYLVANIA
3910 CHESTNUT STREET
PHILADELPHIA, PA 19104-3111
TEL (215) 898-2100 FAX (215) 898-9804

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NATIONAL CENTER ON ADULT LITERACY
UNIVERSITY OF PENNSYLVANIA
3910 CHESTNUT STREET
PHILADELPHIA, PA 19104-3111
PHONE (215) 898-2100 FAX (215) 898-9804

The National Center on Adult Literacy (NCAL) was established in 1990 by the U.S. Department of Education, with co-funding from the Departments of Labor and Health and Human Services. The mission of NCAL addresses three primary challenges: (a) to enhance the knowledge base about adult literacy; (b) to improve the quality of research and development in the field; and (c) to ensure a strong, two-way relationship between research and practice. Through applied research and development and dissemination of the results to researchers, policymakers, and practitioners, NCAL seeks to improve the quality of adult literacy programs and services on a nationwide basis. NCAL serves as a major operating unit of the Literacy Research Center at the University of Pennsylvania.

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THE MILITARY EXPERIENCE AND WORKPLACE LITERACY:

A REVIEW AND SYNTHESIS FOR POLICY AND PRACTICE*

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Abstract

The most extensive research and development on workplace literacy has been accomplished by the U.S. military. This research is reviewed here in four parts. Part 1 summarizes research to develop a conceptual model of literacy and its development. Part 2 summarizes research on the assessment of literacy and other cognitive skills from World War I to the present. Part 3 examines approaches to identifying the literacy demands of jobs that include predictive validity and task analysis methods. Part 4 reviews five major workplace literacy programs developed by the military, including the literacy program of World War II, the Functional Literacy (FLIT) program, the Job-Oriented Basic Skills (JOBS) program, the Job Skills Education Program (JSEP), and the Experimental Functional Skills Program (XFSP). Major findings are that (a) literacy is highly related to measures of intelligence and aptitude; (b) the breadth of one's knowledge is highly related to literacy and job performance; (c) literacy and job performance are continuously related (there is no literacy "gap" to be found in the hundreds of studies by the military); (d) there is no technical solution to the problem of setting standards for literacy (judgment by those involved is required); (e) there is no one best method for identifying the literacy demands of jobs; and (f) workplace literacy programs can produce significant improvements in job-related reading in fairly brief periods of time. However, continued opportunities for education and learning are required to develop high levels of literacy. It is hypothesized that investments in adult literacy and lifelong learning may provide the best strategy for improving the economy, the home, community and the education system.

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INTRODUCTION

The international press recently reported studies by the Organisation for Economic Co-operation and Development (OECD) that concluded that in many industrialized nations, the developmental sequence is not as effective as it should be in producing adults with the literacy skills needed to meet the demands of contemporary society, particularly in the world of work. Many of the young adults entering the workforce are considered lacking in basic reading, writing, and mathematics skills. According to the OECD, "functional illiteracy" is a growing problem in the workforces of many industrialized nations (Wheatley, 1992, p. 11).

A news story reported that in the United States, the Secretary of Labor expressed concern that some 20% of high school graduates could not read their own diplomas. In Canada, over 40% of adults were considered so lacking in literacy skills that they could not meet most everyday reading demands. German officials estimated that there were between 500,000 and 3 million illiterates in Germany. In France, the Ministry of Defense estimated that of over 400,000 young men called up for military service in 1990-91, 20% could not adequately read and understand a 70-word text.

In many nations, a major factor contributing to workforce and workplace literacy problems, in addition to the failure of the developmental system for enculturating literacy mentioned above, is that immigration introduces into the workforce a number of people without the oral language and literacy skills of the dominant society. Many of these immigrants may also be illiterate or only marginally literate in their native languages. In the United States, for instance, one of three students enrolled in adult basic education studies English as a second language (U.S. Department of Education, 1991). In California, some 80%of the enrollments in adult basic education programs are adults seeking English as a second language training (California Workforce Literacy Task Force, 1990).

In addition to the general workforce literacy problems identified by the OECD study, problems of specific workplace literacy were also reported. Here, the OECD considered that the problem was not one of failing to meet literacy standards upon entrance into the workforce, but rather one in which the literacy demands of jobs in particular workplaces had changed. In this case, previously qualified workers faced new literacy demands for which they were no longer qualified.

While acknowledging the paucity of trustworthy data, the OECD opined that about one third of workers could do their jobs better if they were more literate. In one survey, about one third of Canadian firms reported serious difficulties in introducing new technology and increasing productivity because of the poor skills of their workers.

ISSUES IN WORKFORCE AND WORKPLACE LITERACY

The OECD report raises a number of issues regarding workforce and workplace literacy. The major issue is the concept of the "literacy gap." This refers to the idea that the literacy requirements of work in a society can be considered in terms of supply and demand. On the supply side, the home, community, and schools are supposed to continuously produce new generations of adults who form a workforce with a supply of literacy that meets the needs for literacy in the society. On the demand side, the roles of citizen, family member, community service provider, and worker are considered to demand certain types and amounts of literacy for satisfactory performance. For the role of worker, a given workplace is considered to pose particular demands for literacy. The problem of workplace literacy, then, is to have the supply of literacy in the workforce meet the demands for literacy in the workplaces of the society.

These supply and demand issues raise other issues. One of these is how to understand the nature of literacy, so that the home, community, and school can promote the development of the literacy skills of its new adults. This is not a straightforward problem. For instance, in a major policy-oriented report on literacy in the United States, one that focuses on work-related needs for literacy, the authors include a chapter that discusses "... the fact that literacy is a continuum of skills" (Brizius & Foster, 1987, p. 24). Yet on the very same page they discuss the U. S. Department of Education's National Assessment of Educational Progress 1986 assessment of adult literacy and the fact that it tested literacy skills in three areas of competency: prose literacy, document literacy, and quantitative literacy. In this case, the test developers considered that these three domains were different kinds of literacy and three different scales were developed for measuring these three different kinds of literacy. Literacy was considered not as *a continuum* but rather as *three continua*.

Further confusion surrounding the understanding of just what is meant by the term "literacy," particularly as it relates to workplaces, is found in the U.S. Department of Education's National Workplace Literacy Program. Published rules and regulations for this program require that projects funded under the program "... demonstrate a strong relationship between skills taught and the literacy requirements of actual jobs" and "... use curriculum materials ... that reflect the needs of the workplace"(Federal Register, June 5, 1992, p. 24131).

In the Description of Program section, it is stated that "The Secretary [of Education] provides grants . . . to projects designed to improve the productivity of the workforce through improvement of literacy skills in the workplace" by, among other things, "providing adult literacy and other basic skills services and activities"; "improving the competency of adult workers in speaking, listening, reasoning, and problem solving"; and "upgrading or updating basic skills of adult workers in accordance with changes in workplace requirements, technology, products, or processes" (Federal Register, June 5, 1992, p. 24130).

In a "question and answer" section of the same document, the confusion in the meaning of the term "workplace literacy" in general and the foregoing statements in the Federal Register in particular shows itself in several "Q & A's":

Q. What costs are not allowed using project funds?

A. Life skills such as balancing a checkbook, learning to read to children; writing personal correspondence, etc.; job skills or vocational training such as direct training in Statistical Process Control rather than literacy skills needed for SPC.

Q. May a project provide vocational or job training activities?

A. No. Projects must provide adult education programs that teach literacy skills needed in the workplace. Workplace literacy activities include only the adult education activities listed in the Description of Program section of the Notice Inviting Applications. This list does not include vocational or job training activities such as auto mechanics, dye casting, tailoring, and statistical process control. Workplace literacy instructions, however, may enable individuals to benefit subsequently or simultaneously from advanced vocational skills training. For example, this program could support classes in math skills necessary for statistical process control but not a program of statistical process control itself. (p. 24146)

In discussing assessment and evaluation issues, the Federal Register regulations invite the use of measurement instruments ". . . that measure the attainment or enhancement of job-specific basic skills." Regarding curriculum, the Federal Register invites proposals that develop, validate, refine, reproduce, and disseminate basic skills curricula that (a) are based on an analysis of literacy skills required for job competencies; (b) simplify job-based materials to create a systematic curriculum that brings workers to the level of basic skills competency required for a current or future job; and (c) may be transferable to businesses or industries of a similar type or size (p. 24131).

Point (a), above, suggests that a number of different literacy skills might be identified for different job "competencies." Point (b) implies that, instead of various literacy skills, some "level" of basic skills competency can be identified for current or even future jobs, and that a curriculum could be developed to bring workers to that level. Point (c) suggests that, even though measurement instruments that assess job-specific basic skills are called for in the evaluation of workplace literacy programs, basic skills curricula might be developed that produce either different types of literacy skills or different levels of literacy skills that are "transferable" to similar businesses and industries.

The confusion about "literacy," "workforce literacy," and "workplace literacy" that is illustrated in the policy statement by Brizius & Foster (1987, p. 24), which was supposed to inform the decision making of governors in the various states, and the rules and regulations of the U.S. Department of Education's National Workplace Literacy Program given in the Federal Register, are illustrative of the wider confusion among academics, researchers, practitioners, policymakers, and business leaders regarding how to (a) characterize the nature of literacy and assess the literacy abilities of adults; (b) determine the needs for literacy in various life circumstances, including the workplace; (c) how to develop adult literacy programs; (d) measure the improvements in literacy skills made in literacy programs, including workplace literacy programs; and (e) determine if the improvements in the literacy skills of the workforce contribute to the increases in productivity in business and industry that the OECD and many national governments feel is needed.

WORKPLACE LITERACY IN THE LARGER CONTEXT OF HUMAN ABILITIES AND WORK

A further problem in understanding workplace literacy issues is that *literacy* is frequently thought of as either something separate and distinct from other human cognitive abilities, or, at other times, as something synonymous with *all* cognitive ability (e.g., cultural literacy, family literacy, computer literacy, geography literacy, science literacy, workplace literacy, etc.). From the former point of view, it is widely believed that *intelligence* is something that people possess in greater or lesser amounts and that intelligence influences whether and to what extent people can develop literacy ability. In the field of special education, whether a person exhibiting poor reading skills is considered a *slow learner* or *learning disabled* is determined in large measure by the gap between the person's score on an intelligence test and on one or more reading tests (Stanovich, 1991). If the person's score on the intelligence test gives a *mental age* that is two or more years higher than the person's reading grade level (e.g., the *reading age*) then the person is considered as a good candidate for being labeled *learning disabled* rather than *slow*.

Leaving aside the controversial aspects of this methodology for determining whether a poor reader is learning disabled, it is important to note that the methodology suggests that something called intelligence exists as an aspect of human cognition and that something called literacy (reading in this example) exists that is separate from intelligence. Further, it is assumed that one could be highly developed in one of these aspects of cognition (intelligence) while being poorly developed in the other (literacy). What is not so frequently debated, however, is whether it is likely, or even possible, that one could be quite highly developed in literacy but poorly developed in intelligence.

This issue was broached by Carroll (1987) in his discussion of the National Assessment of Educational Progress. He made the point that, although it is probably not popular to say, at the higher levels of difficulty, many of the literacy tasks resemble the kinds of tasks found on tests of verbal intelligence or aptitude. In his discussion, he raises the possibility that because high levels of verbal intelligence may be needed to achieve high levels of literacy, and we have not had much success in raising the performance of adults on measures of verbal intelligence, it might not be possible, except with extraordinary efforts, to raise large numbers of less literate adults to the very high levels of workplace literacy that many feel are needed for work in high performance, high wage, workplaces (U. S. Department of Labor, 1991, p. 3).

The idea that *intelligence* or verbal, quantitative, and other *aptitudes* are fully developed, stable, and largely unmodifiable characteristics of people by the time they are 16 or 17 years old (Bloom, 1964) is widely accepted throughout the industrialized world among both general citizens and specialists in psychological testing.

The *general citizen* point of view was expressed by syndicated columnist Joan Beck of *The Chicago Tribune* in an article that argued for investments in early childhood education because, "Half of adult intellectual capacity is already present by age 4 and 80 percent by age 8 . . . No matter how good schools are, how capable and caring the teachers, they will not have as much effect on a child's *permanent* [italics added] level of intelligence as has the environment in which he has lived before he started to first grade. A school may teach him a zillon facts and inspire him to use the mental capacity he has, but the opportunity to influence his basic intelligence—considered to be a stable characteristic by age 17—is greatest in early life" (Beck, 1991, p. C-2).

The concept of more or less fixed levels of verbal and quantitative aptitudes is prevalent among all of the military establishments of the industrial powers. These nations maintain psychological testing groups that develop and use tests of *mental aptitudes* to screen military recruits (Gal & Mangelsdorf, 1991). Most colleges in the United States include tests such as the Scholastic Aptitude Tests (now called *achievement* tests) in their selection procedures, and the use by business and industry of tests such as the Differential Aptitude Tests (DAT) and the U. S. Employment Service's General Aptitude Test Battery (GATB) is widespread (Fremer, 1989, p. 61-80).

The importance of the concept of more-or-less stable aptitudes in understanding the cognitive demands of work is illustrated by the fact that while the U. S. Department of Education's National Workplace Literacy Program funded some $60 million dollars in over 200 projects to improve the literacy of workers in the years from 1988 to 1992 (U. S. Department of Education, 1992), in the decade from 1983 to 1992, the U.S. Department of Defense and the four military services spent more than half that amount, $36 million in just one project, trying to improve their ability to measure aptitudes and job performance so that a better job of screening and job placement could be done (Wigdor & Green, 1991, p. 71). This was in addition to the millions of dollars that the military services annually spend on routine personnel studies of aptitudes and the prediction of success in job training and completion of military service.

That the military services would rather devote resources to aptitude testing for selection and assignment of recruits to jobs than to the development of workplace literacy programs is confirmed by the fact that, since 1980, the Department of Defense and the military services have pursued a policy of recruiting primarily high quality applicants who have a regular, four-year, high school diploma and are in the top half of the aptitude distribution determined by the Armed Forces Qualification Test (AFQT), which is characterized as a measure of "trainability." (Henderson, 1991).

Commenting in *The Washington Post* on the results of a study of lower aptitude, less literate military personnel, the Department of Defense's Director of Accession Policy said that, "The lesson is that low-aptitude people, whether in the military or not, are always going to be at a disadvantage. That's a sad conclusion" (McAllister, 1990). One of the researchers who conducted the study for the Department of Defense was quoted as saying, ". . . by the age of 18 or 19, it's too late. The school system in early childhood is the only place to really help, and that involves heavy participation by the parents" (Anderson & Van Atta, 1990).

Although the results and interpretations of the foregoing study have been questioned (Sticht, 1992a), the main point here is that they reflect the widespread belief in both the military and civilian communities that *intelligence* or *aptitude* are fixed, stable characteristics of youth and adults by the age of 17, and rather than spending time and money on adult literacy education for low aptitude people, it is considered more cost-beneficial to screen people for work and either discard them or place them in jobs for which their aptitudes suit them (Zeidner & Johnson, 1989).

DEPARTMENT OF DEFENSE RESEARCH ON WORKFORCE AND WORKPLACE LITERACY

Implicit in workforce and workplace literacy initiatives by educators is the belief that adult cognitive skills can be adequately defined, measured, used for counseling and job placement, and modified through instruction to improve productivity in the workplace. Further, it is believed that as workplaces change, either through the introduction of new technology or new organizational structures (the high performance organization), demand for literacy skills may change, generally increasing, and that these changes can be identified and the workforce can be educated to meet the new demands for literacy.

At the present time, there is only one workplace organization in the world that has conducted research and development into adult cognitive skills that addresses the full range of issues and beliefs stated above. That organization is the U.S. Department of Defense with its associated military services: the Army, Navy, Marine Corps, and Air Force. This report provides an interpretive review of research and development projects concerned with workforce and workplace literacy conducted by the military services of the United States over the last 75 years. The following brief sections preview the major parts of this report.

PART 1: THE HUMAN COGNITIVE SYSTEM AND A DEVELOPMENTAL MODEL OF LITERACY

The research reviewed is interpreted within a conceptual framework developed over a twenty-year period (from the late 1960s to 1990) in projects aimed at better understanding the literacy abilities of lower aptitude military personnel and how the military services could best train and utilize these personnel. The conceptual framework formed the basis for several military research projects to develop literacy assessment tests, methods for determining the literacy demands of work in the military, and workplace literacy programs. This theoretical framework is presented and used to interpret major bodies of military research in cognitive assessment and training over the last 75 years.

PART 2: ASSESSING COGNITIVE SKILLS

The military's experiences in mental testing from World War I to the present are summarized. As in the civilian context, the military has displayed considerable confusion about the nature of cognitive abilities, including literacy. Nonetheless, it has operationalized cognitive assessments because of their empirical utility in selecting adults for military service and assigning them to training for particular career fields.

In this report, the military's mental testing procedures will be interpreted within a conceptual framework that includes a simple model of the architecture of the human cognitive system, an information processing interpretation of the various aptitude and literacy tests that the military has studied and utilized over the years, and a developmental model of literacy that military researchers have used in developing both literacy assessments and literacy training programs.

PART 3: ASSESSING THE COGNITIVE DEMANDS OF MILITARY JOBS

The military services have pioneered the study of the literacy and other cognitive skills demands of jobs. This research has included traditional studies of the validity of cognitive tests such as the Armed Forces Qualification Test (AFQT); various reading, arithmetic, and listening tests; and other cognitive tests for predicting job performance. It has used a variety of criterion indicators of job performance, such as success in training, completion of the first term of military service, supervisor's ratings of job performance, job knowledge tests, and job sample tests. In this *predictive validity* approach to identifying the cognitive skills requirements of jobs, the goal has been to state the cognitive demands of work in terms of scores on the predictor tests associated with scores on one or more of the job performance indicators.

A second approach to the study of the knowledge and skills demands of work has involved various methods of job and task analysis. The most extensively used methods are those based on the Air Force's Comprehensive Occupational Data Analysis Program (CODAP) (Payne et. al., 1992). The purpose of the job and task analysis procedures such as the CODAP is to identify the knowledge and skills that personnel need to be trained in upon entry to the job and at advanced stages of career progression.

For identifying the literacy requirements of jobs, special analytical procedures have been developed at different times by the various military services. One such approach, developed under Army and Navy sponsorship, involves observing workers at their job sites, interviewing them in order to identify the types of reading tasks that they perform, and collecting and analyzing reading materials to identify the reading demands of the job (Sticht, Caylor, Kern, & Fox, 1971; Sticht, Fox, Hauke, & Zapf, 1976). This methodology was widely used by Mikulecky (Mikulecky & Diehl, 1980) in studying literacy in civilian occupations and became the basis for the U. S. Departments of Education and Labor recommendations for conducting a *literacy task analysis* of jobs to determine their literacy demands (U. S. Departments of Education & Labor, 1988). Because of the importance of this method of literacy task analysis to civilian workplace literacy programs, it will be reviewed and critiqued here in relation to other methods of literacy task analysis.

PART 4: WORKPLACE LITERACY PROGRAMS IN THE MILITARY

Army historians report that concerns for *workplace literacy* were addressed during the Revolutionary War by General George Washington when he directed chaplains at Valley Forge to teach basic skills of reading, writing, and arithmetic to soldiers (Weinert, 1979). Some two hundred years later, following a mistake in the enlistment screening testing that permitted over three hundred thousand applicants for military service to join whose literacy skills were actually too low to meet standards, literacy (including mathematics) training in the four military services involved more than 200,000 course enrollments with combined contract and student costs in excess of $70 million (Sticht, 1982, p. 3). This is more enrollments in adult basic education than was found in 1979 in twenty-five of the state adult basic skills programs in the United States.

Following the correction of the enlistment testing mistake that lasted from 1976 to 1980, the armed services raised their mental quality standards to the highest they have ever been. Despite this, however, both the Army and Navy continue to provide workplace literacy programs for entering recruits and for upgrading the literacy skills of experienced personnel (Payne et. al., 1992, pp. 118-124).

The final section of this report reviews research on literacy training programs from World War II to the present, interpreted within the conceptual framework of cognitive development. This framework is used for integrating the military research and development in assessing the cognitive skills of personnel, the cognitive demands of work, and the design of workplace literacy programs.

PART 1: THE HUMAN COGNITIVE SYSTEM AND A DEVELOPMENTAL MODEL OF LITERACY

MILITARY TESTING

During World War I, military psychologists developed two tests of intelligence: the Army Alpha test for literates and the Army Beta test for illiterates and non-English speakers. The Beta was administered in pantomime with a minimum of language use; the idea was that intellectual processes could be exhibited with or without the use of oral or written language skills. In the mid-1960s, the military services lowered the aptitude requirements for military service and admitted hundreds of thousands of personnel with low literacy skills. Studies were initiated to determine whether it would be feasible to substitute listening for reading in many training situations. It was believed that much knowledge could be exhibited and learned by either written or spoken language, and therefore, persons with low literacy skills might be taught using oral language.

Both the World War I and the 1960s projects were based implicitly upon a simple model of the human cognitive system (see Figure 1, Appendix B). In this model, there are two bodies of knowledge, one inside and the other outside the person's head. The internal knowledge is stored in long-term memory and is operated on by information-processing procedures in the short-term or working memory. These procedures may include searching for, locating, and retrieving information from the long-term memory knowledge base. The information may be represented internally in either images or language. It may be thought about and then dismissed from working memory. It may be represented outside the person's head through pantomime, such as the Army Beta test. It may be represented through spoken language, such as the listening studies in the 1960s, or through written language, such as the Alpha tests and all aptitude and reading tests used by the military services since World War I.

From the point of view of this simple model, to learn about another person's cognitive make-up, the person's knowledge base and information-processing abilities are addressed by some form of language, written, spoken, or gestural. For instance, in a reading vocabulary test, the written words on the test are presented to the examinee who is supposed to read the words into working memory while looking up the meanings in long-term memory. The person is then supposed to make a response that indicates the outcome of this information-processing activity.

A DEVELOPMENTAL MODEL FOR LITERACY IN FOUR STAGES

Social groups with shared cultural experiences form normative expectations for what people at different ages can and cannot be expected to do. One will not address a person's cognitive system in a form that the person is not expected to be able to process. For instance, one does not typically hand a written note to a two-year-old to ask for personal information such as a name, but one does ask for the name using oral language. The normative assumption is that a typical two-year-old can talk and comprehend simple oral language but cannot read. Similarly, one does not ask an infant for information. It is assumed that infants cannot comprehend and speak oral language well enough to communicate, but facial expressions, gestures, and laughing sounds might be used to communicate with the infant and receive responses such as laughing, smiling, and hand and arm movements in return. In short, our literate society has expectations for how infants, two-year-olds, six-year-olds, adolescents, and adults develop their cognitive systems over time. We have an implicit developmental model of literacy that guides our choice of communication methods in different circumstances.

This implicit developmental model of literacy was made explicit and is presented schematically in Figure 2, Appendix B. (See Sticht, Beck, Hauke, Kleiman & James, 1974 for an extended discussion of an earlier version of the developmental model of literacy and a review of literature related to hypotheses derived from it.)

Before addressing the details of the model, several orienting comments are in order. First, Figure 2 in Appendix B is meant to portray a developmental sequence from left to right. The sequence begins with the newborn infant and goes through Stage 4 in which literacy skills are functional. The broad arrowhead on the far right is meant to imply that the development of literacy, language, and knowledge is a lifetime process.

The top series of boxes represents the environment in which the person exists. The environment makes available external information displays that the person can explore and transform into internal representations. These internal representations are developed by the processes in the second series of boxes labeled *information processes in working memory*. These processes merge information derived from the external information displays with information derived from the third series of boxes labeled *long-term memory*. Thus, the processes in the working memory are used to pick up information from outside the brain and merge it with information in long-term memory inside the brain to construct an internal representation of the world as currently experienced, including the meaning of symbolic information when this is a major domain of information being extracted from the external world at a given time. The top of Figure 2 in Appendix B refers to four *stages*. The concept of *stages* does not refer to automatic and immutable cognitive *unfoldings*, but rather to what would typically be observed at different times when one studies children growing up in our literate society.

Basic Adaptive Processes

Stage 1 refers to the newborn infant who is considered to be innately endowed with *basic adaptive processes* including sensory/perceptual processes such as hearing and seeing; motor movement; and cognition, including the processes needed to acquire information, mentally manipulate it, store it in memory, form knowledge structures out of it, and retrieve and represent the information in various ways. Stage 1 processes are assumed to work more or less automatically and without conscious control; hence, an observer would note that the infant seems captured by stimuli, rather than selective in observing information in the world.

Conscious Control and Memory

Stage 2 represents the emergence of active, conscious control over information perception and manipulation, and distinguishes listening from hearing and looking from seeing. Listening and looking build internal representations that may be called *images*. Images may also be constructed from data stored in long-term memory. These internal imaging processes are frequently termed in aptitude tests as *spatial perception* or *mechanical comprehension* and assess the ability to visualize and rotate cog-and-gear assemblies and determine the effects this movement might have on another gear.

Stage 2 also introduces the concept of active or *working memory*, which is defined by the occurrence of consciously controlled information processing activities. Working memory is limited and can be easily overloaded (e.g., attending to two or three things at once is difficult, if not impossible). Many of the information-processing activities a person acquires will be techniques to overcome the limits of active memory (e.g., repeating information to oneself keeps the information in active working memory until it can be applied). A stage of cognitive development is shown by the ability of the infant to attend to information selectively; this is a cognitive capability which, once developed, is a permanent feature of cognition and distinguishes the Stage 2 child from the Stage 1 child.

Language Development

Stage 3 represents the development of language processes out of earlier processes and knowledge stored in long-term memory. In developing oral language, the listening process is used to attend to spoken language, to learn the words and grammar of language. Thus, listening and languaging occur simultaneously; this joint occurrence is given the special name of *auding*. On the production side, the joint occurrence of (a) uttering (making sounds through the mouth) with the selection of word forms from the language pool and (b) stringing those word forms together to make sentences using the rules of grammar produces the special process called *speaking*. Auding and speaking comprise the oral language information reception and production skills. Speaking is used to represent information that the person has outside the head and in the acoustic medium, while auding is used to pick up and transform speech information displays into knowledge in the mind of the listener. To an observer, the Stage 3 child can respond to and produce oral language, at least to some minimal degree. Again, as with conscious attending, once oral language has begun to emerge, the cognitive system is permanently modified (barring physiological trauma), and the person is no longer capable of exclusively prelinguistic modes of thought.

Processing Representations

In transitioning to *Stage 4*, the information-processing skills of *looking* and *marking* are used to learn a system which represents the spoken language in a different medium (light) and in a more or less permanent graphic display (the written language). Looking at written language and transforming the written language into meaning is called *reading*. *Writing* is the special use of marking skills to produce graphic language (and other symbols and symbol systems).

SCHEMA BUILDING AND EFFECTS ON LITERACY SKILLS

Typically, people develop a fair amount of competence in oral language before they are exposed to formal instruction in reading in elementary grades (though informal learning of literacy may begin in the home and community in literate cultures). Written language skills build upon oral language skills and add new vocabulary and concepts, as well as special knowledge about how to represent information in the graphic medium to the person's knowledge base. In turn, learning new vocabulary and conventions of language through reading and writing enlarges the person's oral language abilities. The large arrow at the far right in Figure 2, Appendix B, is meant to represent the notion that the development of oral and written language ability may continue indefinitely as the person studies and develops new knowledge domains.

A major component of Figure 2, Appendix B, is long-term memory, or the *knowledge base*. The long-term memory contains all the knowledge developed in interaction with the environment. Much of the knowledge acquired by the person will not be consciously understood (e.g., the rules of grammar). Rather, it will be used unconsciously to accomplish tasks such as developing language competence and comprehending the events of the world. In addition to the general world knowledge and processes that are in the mind, though not necessarily accessible to conscious understanding without considerable analysis, the memory also contains the language knowledge (words and grammar) that can be used to represent information that arises from experience in the world (e.g., bodies of knowledge about machines, parts of the body, houses, neighborhoods)—sometimes called *schema* (Rumelhart, 1980) or *mental models* (Rouse & Morris, 1985)—and from didactic instruction such as from training programs.

The model holds that the development of the oracy skills of speaking and auding build upon the prior development of prelinguistic knowledge through information-processing activities. It is important to understand that this early, prelinguistic cognitive content (or knowledge) will form the foundation for the acquisition of new knowledge over the person's lifetime, including that knowledge known as *literacy*.

Much of this knowledge will remain personal and will not be explicitly used in language for communication with others. Nonetheless, such personal, tacit knowledge, which includes perceptual learnings and general knowledge of how the world works, will be necessary for learning to comprehend the spoken and later the written language. This reflects the fact that language is selective in the features and concepts chosen to be represented. Language may be thought of as producing a verbal *figure* that can be comprehended only in terms of its relationship to a nonlinguistic conceptual *ground of world knowledge*. A simple illustration of the role of world knowledge in literacy training is seen in the recommendation to give students experience with objects and events in the world through field trips, demonstrations, movies, and so forth, before they read about them. This approach provides an experiential base, or world knowledge, which will permit a deeper comprehension of the words and concepts the students read and greater access to prior knowledge via perceptual learning (Bransford, Sherwood, Vige, & Rieser, 1986).

A final aspect of the model is that it recognizes that the literacy skills of reading and writing utilize the same knowledge base that is used in auding and speaking, plus the special decoding and encoding skills of reading and writing. This, as well as the very nature of the written language display—characterized by being more or less permanent, being arrayed in space, and utilizing the features of light (color, contrast)—makes possible the development of skills and knowledge entirely different from those involved in oral language.

The model incorporates the role of prelinguistic looking and marking abilities as contributors to later utilization of the visual display of written language in conjunction with graphic marks such as lines, white space, and color to develop graphic thinking and problem-solving tools such as matrices, flow charts, color-coded graphs, and so forth. These tools combine with written language and nonlanguage graphic symbols, such as arrowheads and geometric figures, to produce analytical products beyond those obtainable through fleeting, temporal, oral language.

LEARNING AS INFORMATION PROCESSING

A point to be emphasized is the fact that much of the acquisition of literacy is not simply learning to read; that is, it is not just learning a graphic language system that can be substituted for the oral language system. Rather, a large part of learning to be literate (and perhaps the most important part for acquiring higher levels of literacy) is learning how to perform the many tasks made possible by the unique characteristics of printed displays—their permanence, spatiality, and use of light—and using that knowledge to develop large amounts of new knowledge.

The developmental model of literacy emphasizes two features.

- *An architecture for the human cognitive system that contains a long-term memory (knowledge base) and a working memory.* The mind draws upon certain procedural knowledge, including language, that is in the long-term memory and uses that procedural knowledge for processing information taken both from the long-term memory and from the external world. The latter serves as a sort of *external memory* that displays information to be picked up by the sensory systems and internal processing skills and merged with prior knowledge in the process generally called *learning*.
- *The development of additional knowledge, including that knowledge known as literacy, as extensions to or transformations of earlier knowledge.* In particular, the developmental model emphasizes the evolution of oral language from earlier prelinguistic knowledge and literacy as an amalgam of prelinguistic (Stages 1 and 2) and linguistic (Stage 3) knowledge. Literacy includes the procedural knowledge (processes) used in guiding information pickup and processing by the visual, auditory, and other perceptual systems, and declarative knowledge generally representable in oral and graphic symbol systems (this includes content knowledge such as mathematics, geography, etc., when learned).

The conceptual framework used in interpreting literacy research in the military services also includes a conception of learning as the outcome of constructive information-processing activities.

The information-processing approach to learning emphasizes the internal mental processes involved in learning. It views the person as an active, adaptive organism busily ordering and arranging an internalized representation of life space. According to this view, learning is the result of an active, constructive process on the part of the learner working with information from the internal or external environments. This differs from a strict behaviorist conception in which learning is the result of some fixed, automatic process of association among stimuli, responses, and their consequences. Rather it emphasizes internal strategies for dealing with information, such as the use of imagery or mnemonic (contextualizing) devices to aid in learning a list of words. Thus, it would lead us to seek different internal processing strategies even though certain stimulus-response sequences may be the same. For instance, interest would focus not only on whether a problem is solved, but also upon how it was solved. It is thus analytic, stressing a detailed analysis of tasks in regard to the knowledge and mental operations involved inside the head between the occurrence of a stimulus and a subsequent response (i.e., cognitive task analysis).

A most important aspect of the information-processing approach to learning is the emphasis upon the active, constructive nature of the process of drawing upon prior knowledge to function in the current learning context. This suggests that cognitive assessment and instructional programs should offer (a) an environment for and a stimulus to active information seeking; (b) mental representation and re-representation to bring a larger share of prior knowledge to bear on the learning task; and (c) external communication to check, confirm, and further develop learning.

SUMMARY

In summary, the theoretical framework used to interpret military research on literacy includes the concept of a human cognitive system comprised of a long-term memory with its knowledge base and a short-term working memory that operates through information-processing activities on the information in the long-term memory and the external world of information. Cognition includes both knowledge and the processes for developing knowledge. The long-term memory develops over the life of the person as the latter undergoes the transitions from prelanguage, to oral language, to written language-based information processing. As the peak developmental information-processing outcome in our literate society, the person comes to acquire the information-processing skills involved in a wide variety of cognitive acts involving graphic symbol systems for language processing and for performing various cognitive tasks involved in problem solving and reasoning. This developmental progression occurs as the result of active, constructive information-processing activities that represent and re-represent knowledge to forge new learning from old. The new knowledge adds to the knowledge base in the long-term memory and is activated in various contexts through constructive processes that are sensitive to the different contexts. This means, for instance, that even though one possesses certain knowledge and skills, they may not be accessed if the context in which the person is immersed does not activate them.

This conceptual framework is used to reinterpret and summarize a large body of research in the military services concerned with the assessment of cognitive skills, including literacy.

PART 2: ASSESSMENT OF COGNITIVE ABILITY

OVERVIEW

For over 75 years, the armed forces have pursued a policy of assessing the mental ability of adults who are eligible for military service. In World War I, 1.9 million men were tested on the Army Alpha and Beta tests of intelligence. The initial use of these mental tests reflected the military's need to rapidly mobilize a force that was the first to fight in the era of modern mechanization. During the Civil War, over 90% of the male enlisted force was involved in general military, combat-related activities; craftsmen (blue collar) and clerical or technical personnel (white collar) made up less than 10% of the force. By World War I, however, general military personnel had declined to less than half the force, and there was a need for large numbers of semi-skilled and skilled personnel. The goal of those who introduced mental testing into the military was to supplement traditional personnel procedures in assigning men to crafts and jobs of varying complexity (Yerkes, 1921, p. 153).

Figure 3 (based on data from Eitelberg, 1988, p. 13) found in Appendix B shows the decline of military/combat occupational groups and the rise in blue collar and white collar occupations in the military from World War I through the Vietnam War. Since around 1965, the distribution of personnel in three occupational groups has been relatively stable: around 15% general military/combat, 40% blue collar, and 45% white collar.

Because of the changes in the types of military jobs, it has been argued that the modern military is so technologically complex that personnel of high mental quality are needed to use, maintain, and repair the tools of war (Binkin, 1986). This is an argument similar to that increasingly heard in the civilian world in discussions of workplace literacy. Our technologically complex society demands higher levels of literacy than in the past (Venezky, Kaestle, & Sum, 1987). Interestingly, when discussed in the military context, the need is for personnel of higher *aptitude*, yet when discussed in the civilian context, the need is for citizens of higher *literacy*. These perspectives appear to reflect the different origins of mental tests in the military; tests were construed to be measures of innate *intelligence* and not *achievement* per se. Even today, these ideas appear commingled in military management documents:

> Aptitude tests are designed to reveal an individual's innate intellectual abilities, interests, and experiences in a wide variety of activities, as influenced by education and training. Achievement tests are designed to measure skill and knowledge accomplishment in specific subject areas. (Office of the Assistant Secretary of Defense [Force Management and Personnel], 1987, II-18—II-19)

The distinction between aptitude and achievement is drawn by the military even though the Armed Forces Qualification Test (AFQT), the major screening test of aptitude for *trainability,* is made-up of reading (word knowledge and paragraph comprehension) and arithmetic (mathematics knowledge and arithmetic reasoning) tests, both basic skills that are generally thought of as achieved through education and training, not as indicators of innate intellectual abilities. Yet the AFQT is considered by the military as an aptitude test, not an achievement test.

If we accept the position that the AFQT measures literacy and arithmetic, that is, basic skills, then the military's experience in enlisting, training, and utilizing personnel with low levels of literacy can provide insights regarding what literacy levels may suffice for learning and performing jobs of different technological complexity.

Over the years, the mental ability tests used by the armed services have changed in content and in the definition of what they measure (see Table 1, Appendix A), but they still represent attempts to assess the cognitive skills of adults and to use that information to select people for military service in order to assign them to work for which their aptitudes suit them.

Four major periods in the history of military mental testing are considered in the present report:

- introduction of mental testing, mostly as a developmental activity, during World War I;
- large-scale, operational use of mental tests for classifying recruits into job assignments during World War II;
- development of the Armed Forces Qualification Test (AFQT) in the 1950s to screen out low mental ability persons for all military services and to classify recruits into job assignments; and
- introduction of the Armed Services Vocational Aptitude Battery (ASVAB) in 1976 to be used by all military services for both screening and job classification.

WORLD WAR I

The first mental tests for mass testing were developed by psychologists for the U.S. Army in 1917-1918. The group tests were modeled after intelligence tests designed for individual use in one-on-one assessment. In developing the mental tests, the psychologists subscribed to the position that one could be quite intelligent but illiterate or not proficient in the English language. Based on this reasoning, two major tests were developed: the Army Alpha for literate groups and the Army Beta for illiterates, low literates, and non-English speakers (Yerkes, 1921). Both were based on the theoretical position that intelligence was an inherited trait and the assumption that native intelligence was being assessed.

The Alpha Test

The Alpha test battery for literates included a wide range of tests of knowledge and cognitive skills (Table 2, Appendix A). Using the simple model of the human cognitive system (Figure 1, Appendix B), the Alpha test can be reinterpreted not as a test of native intelligence but as a sampling of a wide variety of cognitive abilities assessing a person's knowledge base through both oral and written language.

Test 1 involved auding and comprehending simple or complex oral language directions and looking at and marking in the appropriate places on an answer sheet. To a large extent, this test was a test of the ability to hold information in working memory and to combine earlier instructions with later ones to determine the correct marking responses.

The role of special bodies of knowledge in the performance of information-processing activities is illustrated in the remaining tests. Test 2 required the ability to read and comprehend the stated problem and the knowledge of arithmetic to perform the necessary computations. Again, the test stressed the working memory by requiring the reader to hold more than one phrase that was information bearing, combine the phrases, and perform the required computations. Mathematics knowledge was also required for Test 6.

Test 3 clearly required reading and comprehending language. Additionally, however, it required knowledge of culturally normative expectations to make the correct choice. In terms of the developmental model of literacy, this means that the person's mind would have had to develop in an external environment in which the information needed to make the normatively correct response would be presented in some form. Test 8 also was heavily loaded with cultural knowledge requirements. It was a probe of the person's knowledge base to discover the extent to which it included both very familiar and less familiar declarative knowledge available in U.S. culture.

Specific vocabulary knowledge was required for Tests 4 and 7, in addition to the knowledge of *same* and *opposite* (Test 4) and the content knowledge and information-processing skills (Sternberg, 1977) needed to perform analogical reasoning (Test 7).

Intercorrelations among the eight Alpha tests ranged from a low of .59 for Tests 1 and 3 to a high of .86 for Tests 4 and 8. To determine each person's intelligence level, scores for all eight subtests were combined into one total score. The correlation of Alpha total scores with Stanford-Binet mental age was .81 (Yerkes, 1921, p. 634, Table 155).

A person's total Alpha score was assigned a letter grade: A (superior intelligence); B, C+, C (average intelligence); or C-, D, or D- (inferior intelligence). The letter grade became the person's mental category and was taken as a general indicator of his native intelligence. This position was held even though there was a clear relationship of Alpha scores to years of schooling during which much of the special knowledge, vocabulary, and cultural knowledge would have been developed. Correlations of subtest scores with years of schooling were found in one special study (Yerkes, 1921) to range from .51 for Test 3 (practical judgment) to .68 for Test 4 when low literates and non-English speakers were excluded. With low literates included (but not non-English speakers), these correlations ranged from .60 for Test 7 (analogies) to .74 for Test 2 (arithmetic) (Yerkes, 1921, p. 781, Table 326). Generally, the correlations of Alpha *total* test scores with education ranged from .65 if the low literates and non-English speakers were excluded to .75 when the latter were included (Yerkes, 1921, pp. 779-780). Rather than regarding the Alpha scores as reflecting the results of schooling, the test developers considered that the years of schooling completed reflected the results of the native intelligence measured by the Alpha tests (Yerkes, 1921, p. 783).

The Beta Test

Decisions regarding who should take the Beta test were made frequently in terms of the number of years of education reported. Generally, those with fewer than four to six years of education were sent to Beta testing. Additionally, men who were non-English speakers or very poor in speaking English were sent for Beta testing. In some cases, men who tried the Alpha tests but were subsequently judged to be poor readers were readministered the Beta tests. The procedures were not uniform across the testing locations.

As indicated in Table 2, Appendix A, like the Alpha test, the Beta test battery included a number of subtests. However, the Beta subtest instructions were executed in pantomime. The examinees marked their responses on paper using pencils, but they were not required to use written language (though reading of number symbols was required in some subtests). As with the Alpha, the Beta subtest scores were combined into one score, and that score was used to assign letter grades indicating general intelligence.

Though the attempt was to use the Beta test as an intelligence test freed of influences of literacy and the English language, the subtests had major differences from the Alpha both in terms of the knowledge called for and the skills involved in processing graphically presented information. As noted in the discussion of the developmental model, there are two main aspects to literacy. One aspect is that literacy involves the use of graphics technology to produce a second signaling system for speech, that is, written language is a graphic representation of spoken language to a large degree. However, literacy is also the use of the elements of graphics technology—light, space, and permanence—to produce graphic devices to be used in information processing for problem solving, reasoning, and communicating. It is clear that literacy as the use of graphics technology for problem solving and reasoning was included in every subtest of the Beta (Table 2, Appendix A). Test 1 required looking at the graphically represented maze while reasoning about the path to be taken. Test 2 combined counting cubes in the graphic representation with the use of graphics information and knowledge of the language of arithmetic, while in Test 7, graphics information on the left must be studied and mentally rearranged to construct a figure on the right. Reading graphics displays in left to right sequences, as in written language, was a requirement of Test 3 and a useful processing skill for Tests 4 and 5, as was knowledge of the language of arithmetic.

From the foregoing analysis, it becomes clear that both the Alpha and Beta assessed cognitive skills with the concomitant use of literacy, that is, the ability to utilize graphic marks arrayed in various designs for information processing is common to both tests. The primary difference between the two tests was that the Alpha required extensive reading defined in the developmental model as looking while languaging, while this was not required to any significant degree in the Beta test (though reading the letters and numbers of Tests 3, 4, and 5 included some reading while languaging). In turn, languaging of sentences required the retrieval of semantic information from the knowledge base stored in long-term memory for use in working memory to comprehend the information picked-up from the graphic display in the text of the test. In the Beta test most of the information processing could be done in working memory without the need to locate and retrieve semantically encoded knowledge from the long-term memory.

Intercorrelations among the Beta subtests ranged from a low of .41 for Subtests 1 (Maze) and 5 (Number Checking) to a high of .75 for Subtests 5 (Number Checking) and 4 (Digit Symbol). Perhaps the relatively high correlation of .75 for Subtests 4 and 5 reflects the fact that both made extensive use of number reading (Yerkes, 1921, p. 634, Table 155).

Intercorrelations between the Alpha and Beta subtests, obtained from a sample of men who first took the Alpha and then were referred for Beta testing, ranged from a low of .36 for Beta Test 2 (Cube Analysis) with Alpha Test 3 (Practical Judgment) to a high of .68 for Beta Test 4 (Digit Symbol) with Alpha Test 2 (Arithmetical Problems) (Yerkes, 1921, p. 634, Table 155).

The correlation of Beta total scores with schooling ranged from .45 for a sample of over 11,000 native-born men with education levels ranging from none to college, to .67 for a sample of 653 native-born draftees (Yerkes, 1921, p. 781, Tables 327, 328). For a sample of 5,803 foreign born, the correlation of Beta total score with schooling was .50. In general, the correlations of Beta scores with years of schooling were lower than those of the Alpha test (.75) when the full range of Alpha test takers (including those subsequently sent for Beta testing) was included.

When the Alpha and Beta total scores (excluding non-English speakers) were correlated with mental age scores on the Stanford-Binet individually administered intelligence test, the resulting coefficients were .81 and .73, respectively. Since the Stanford-Binet is essentially an auding test, in which the examiner speaks the questions and the given information, it is perhaps to be expected that the correlation between the heavily language-laden Alpha and Stanford-Binet tests would be greater than the very low language-based Beta test with the Stanford-Binet. For a sample of 653 recruits, the correlation of Stanford-Binet with years of schooling was .65 (Yerkes, 1921, p. 782, Table 330).

Intelligence and Occupations

In a special study by the Surgeon General's Office, psychologists studied the intelligence distributions, as represented by the mental categories derived from the Alpha and Beta total scores, in various occupations (Yerkes, 1921, p. 829, Figure 57). Figure 4, Appendix B, summarizes data from that study and presents information on the literacy levels of young adults in the same occupational categories as determined in a 1985 survey of literacy skills using the document scale (Barton & Kirsch, 1990).

As Figure 4 in Appendix B illustrates, there is a remarkable similarity in the 1919 data on intelligence and occupations and the 1985 data on literacy and occupations. Interestingly, however, 32% of the scores for laborers in 1919 were from the use of the Beta test for low literates or non-English speakers. All of the 1985 scores were for literates. Apparently, the laborers of today are more literate and English speaking than 75 years ago, but the social distribution of cognitive skills in the workforce is the same: the least skilled cognitively occupy the lowest rung on the occupational ladder. The best educated and most skilled occupy the top rungs of the ladder.

Uses of the Alpha and Beta Tests

For the most part, while the Alpha and Beta tests were administered to some 1.9 million men, the mental ability scores were not widely used by the Army in making personnel decisions because the war had ended by the time the tests were developed. However, the introduction to the tests outlined the uses to which it was believed the test results could be put.

> - To classify soldiers according to their mental ability, thus supplementing personnel records of occupational qualifications and assisting with assignment in the Army.
> - To supply a mental rating for each soldier which shall assist personnel officers in building organizations of equal or of appropriate mental strength.
> - To assist regimental, company and medical officers by careful examination and report on men who are not responding satisfactorily to training, or are otherwise troublesome.
> - To assist officers of development battalions with classification, grading, training, and ultimate assignment of men.
> - To assist in discovering men of superior mental ability who should be selected for officer training camps, for promotion, or for assignment to special tasks.
> - To assist in discovering and properly placing men of marked special skill as observers or scouts for intelligence service.
> - To assist in discovering men who are mentally inferior and who in accordance with degree of defectiveness should be recommended for discharge, development battalions, labor organizations or regular military training. (Yerkes, 1921, p. 153)

Though the Alpha and Beta tests were never widely used for operational decision making, their development and the debate regarding their use in the Army produced a way of thinking about intelligence and aptitude that has continued to underpin the use of mental tests in the military. For instance, the tests introduced the concept of *mental categories*, along with the notion that personnel could be reliably and validly assessed with regard to their mental abilities using paper-and-pencil tests and be assigned to a mental category. Later, evidence was obtained which suggested that military supervisors sometimes had their judgments of personnel biased by knowing their mental categories (U.S. Dept. of the Army, 1965, p. 4).

WORLD WAR II

As the United States moved into World War II, new mental tests were developed by the Army and Navy. The Army General Classification Test (AGCT) served as a test of *general learning ability* and was to be used in basically the same manner as the Army Alpha, as an aid in assigning new recruits to military jobs. (Eitelberg, Laurence, Waters, & Perelman, 1984, p. 15). The Navy General Classification Test (NGCT) served similar purposes. Beginning in June 1943, the AGCT was also used to screen out people with limited ability for success in military training.

By the time the AGCT was developed, psychologists in the military personnel research sections considered that:

> ...intelligence tests do not measure native mental capacity. They measure actual performance on test questions. A test is a fairly valid measure of the native capacities which underlie the abilities tapped by its questions when every one tested has had equal opportunity and equal incentive to develop the abilities measured. (Zeidner & Drucker, 1983, p. 34)

As interpreted by Zeidner and Drucker, both long-time members of the Army's personnel research activity, "the Army psychologists' World War II position was that the test scores represented nothing more than an index of measured abilities at the time the test was taken" (p. 35).

Because the Army of World War II had to draw upon a primarily inexperienced young adult population and train recruits in a wide variety of technical and administrative fields as well as mechanized combat jobs, the AGCT was validated as a classification instrument by correlating scores on AGCT with grades in training courses. This seemed consistent with the interpretation of the AGCT as a measure of general learning ability. In content, the AGCT (Table 1, Appendix A) resembled measures of schooling, such as reading vocabulary (verbal ability), arithmetic computation, and word problem solving. Only a measure of pattern analysis differed from school-based achievement tests. Given that the AGCT so much resembled a measure of past school learning, it is not surprising that it was found to correlate with achievement in Army schools.

As in World War I, scores on the subtests of the AGCT were combined into total scores. High scoring recruits, *rapid learners*, were assigned to Army Grade I, next highest to Grade II; then *average learners* to Grade III; *below average* to Grade IV; and *slow learners* to Grade V.

Following World War II, standards for military service were raised, and the AGCT was adapted to screen applicants for military service. With the Selective Service Act of 1948, an entire mental category, Army Grade V, comprising approximately 8% of the young, white, male population, was excluded from service (Wool, 1968, p. 66). This was the first time that a statutory mental standard was set for military service.

KOREA AND VIETNAM

In 1950, the Armed Forces Qualification Test (AFQT) was introduced as the single test that would be used to screen draftees and volunteers for entry into any of the armed services. With some changes in content (see Table 1, Appendix A), the AFQT has remained the primary screening test for military service up to the present. As noted by Eitelberg et al. (1984):

> Unlike the AGCT and the aptitude tests of World War I, the AFQT was specifically designed to be used as a *screening device*. Thus, the AFQT was established for the purpose of both (a) measuring the "examinee's general mental ability to

> absorb military training within a reasonable length of time, so as to eliminate those who do not possess such ability;" and (b) providing a "uniform measure of the examinee's potential general usefulness to in the service, if qualified on the tests." (pp. 16, 17)

In developing the AFQT, care was taken to make certain that slow workers would not be penalized and that the verbal instructions were not so difficult as to obscure the test items themselves. In these ways, the test was designed to be especially useful for identifying the least able.

In practice, the scores on each of the AFQT subtests were combined into a single score, and, as with the Army Alpha and Beta tests and the AGCT, the total scores were grouped into mental categories. Table 3, Appendix A, shows the five categories, the percentile scores corresponding to each, and the distribution of each category in the World War II reference group and the 1980 renorming group.

On June 30, 1951, Congress passed Public Law 51 establishing the minimum standard for entry into military service at the 10th percentile, hence excluding persons in AFQT Mental Category V from service (Maier & Sims, 1986, A-14). In addition, the military services themselves set standards for service that involved primarily the percentage of entrants who could come from Category IV, considered to be made-up of those below average in trainability. In general, the policy has been to lower required aptitude scores during wartime and to raise them during peacetime (Eitelberg et al., 1984, pp. 24-28).

While the AFQT was developed to screen candidates for all military services, each service supplemented the AFQT with test batteries designed to aid in classifying people into occupations. These supplemental aptitude tests have included automotive information, electronics information, shop information, mathematical knowledge, and other areas of special aptitude. In practice, enlistment standards were frequently set such that a low score on the AFQT could be offset by meeting a higher standard on one or more of the special aptitude tests.

By the mid-1960s, the services were using an education standard in conjunction with the AFQT and other aptitude tests to qualify candidates. For instance, in 1962, the Army designated high school graduates with AFQT scores of 31 or higher as fully qualified, and graduates who scored between 21 and 30 qualified if they scored above standards on three special aptitude tests. Nongraduates were required to have AFQT scores above 31, with no off-setting special aptitude scores permitted (Eitelberg et al., 1984, p. 18).

THE ALL-VOLUNTEER FORCE

In 1973 the draft was ended, and the nation entered the contemporary period in which all military recruits are volunteers. In 1976, the Armed Services Vocational Aptitude Battery (ASVAB) was introduced as the official mental testing battery used by all services (see Table 1, Appendix A). The ASVAB combined the AFQT and the special aptitude tests of the various services into one battery that today includes 10 subtests: Word Knowledge, Paragraph Comprehension, Numerical Operations, Arithmetic Reasoning, Mathematical Knowledge, Coding Speed, General Science, Mechanical Comprehension, Electronics Information, and Automotive-Shop Information.

Four subtests on the ASVAB are combined to form the AFQT. From 1976-1980, the AFQT subtests were Word Knowledge, Arithmetic Reasoning (word problems), Spatial Relationships (e.g., determining what kinds of boxes might result from folding two dimensional drawings), and Mechanical Comprehension (e.g., if a lever is moved on a piece of equipment, what cogs and gears would move and produce a change in the equipment). From 1980-1988, the AFQT consisted of Word Knowledge, Paragraph Comprehension, Arithmetic Reasoning, and Numerical Operations (rapidly adding, subtracting, multiplying, and dividing up to two digit numbers). In 1988 Numerical Operations was dropped and Mathematics Knowledge was added.

As with the earlier AFQT, the ASVAB-AFQT is considered as a measure of trainability. Applicant percentile scores on the AFQT are assigned to one of five categories: Categories I and II are considered to be well above average and above average in trainability; Category III represents average trainability; and Category IV is below average. Those scoring in Category V are considered well below average in trainability and are excluded by law from military service (Office of the Assistant Secretary of Defense [Force Management and Personnel], 1987, pp. II-12—II-14).

Today the AFQT and special aptitude subtests of the ASVAB are used both to screen out lower aptitude applicants from military service and to classify applicants according to occupations for which they qualify. As in earlier times, education standards are in effect, and non-high school graduates must have higher AFQT scores than graduates with qualifying special aptitude scores. Alternative diploma holders (GED) must also have higher AFQT scores than high school graduates.

In the 70 years since the military first introduced mental testing on a mass scale, the concept of what it is that the tests measure has changed. At first, the Army Alpha and Beta tests were considered to measure *innate intelligence*. During World War II, the AGCT was considered a measure of *general learning ability*. For the last 40 years, the AFQT has been considered as a measure of *trainability*.

The contents of the military mental tests changed most dramatically from the Army Alpha and Beta tests to the AGCT. Since World War II, the content has always included vocabulary and arithmetic knowledge. From 1941-1980, the aptitude tests included a test of pattern or spatial perception. For 20 years the AFQT included a test of tool recognition; the tool recognition test was replaced with a test of mechanical comprehension for five years. Since 1980, the AFQT has included only reading and mathematics components.

Since World War II, the usefulness of mental tests has been established by determining the correlation between scores on the tests and various indicators of performance in the military. The earliest and most frequently used measure of performance was success in training. The highest correlations have typically been found between the mental tests and course grades. This is why the AFQT is called a measure of *trainability*.

Intelligence, Aptitude, and Basic Skills

Figure 5, Appendix B, addresses the issue of whether it is likely that one can be highly literate but low in intelligence or aptitude. It shows relationships among the AGCT of World War II, AFQT mental categories and percentiles, IQ scores on the Wechsler Adult Intelligence Scale (WAIS), five standardized, grade school-normed tests of reading, one version of the Comprehensive Adult Student Assessment System, and the Reading Proficiency Scale administered by the National Assessment of Educational Progress (NAEP) to 4th-, 8th-, and 11th-grade students. (In 1985 the NAEP Reading Scale was administered to a representative sample of young adults 21 to 25 years old as a part of a survey of the literacy skills of young adults and those results are depicted in Figure 5, Appendix B).

The data suggest that being highly literate but low in intelligence or aptitude is not a likely occurrence. In fact, in studies of the interrelationships of six major reading tests (including the TABE, ABLE, G-M, and N-D tests) with the AFQT, all of the correlations were in the range from .80 to .95 (Waters, Barnes, Foley, Steinhaus, & Brown, 1988, p. 46, Table 15). Given the range of the test-retest reliabilities of the reading tests (from .77 to .92), these intercorrelations of AFQT and reading test scores are about as high as they can get (Waters et al., p. 30, Table 6).

From the developmental model of literacy (refer to Figure 2, Appendix B), it is apparent that literacy is a cognitive capability that develops on the basis of earlier basic adaptive processes. It includes aspects of information processing involved in reasoning about the world in a nonliterate manner; making judgments about experiences in the past, present, and future; and languaging, including learning of words, their meanings, and the rules of syntax. All these information-processing abilities are incorporated into thinking about information picked-up by reading as that skill develops from earlier looking and marking abilities.

An additional factor of importance from the developmental model is the bodies of knowledge about the world that are drawn on in intelligence, aptitude, and literacy tests. The interaction of knowledge and information-processing skills is common to all of these types of assessments. It is to be expected that the correlations between schooling and intelligence, aptitude, and literacy should be moderately high. As one progresses through school, larger bodies of knowledge are developed, along with the vocabulary (lexicon) needed to understand and express aspects of this expanding knowledge base. The data from the Alpha and Beta tests, the AGCT, the AFQT, and numerous reading assessments show a direct, positive relationship to schooling: the greater the number of years of school completed, the higher the scores on the various cognitive tests.

Assessing Languaging by Auding and Reading

The developers of the Army Alpha test recognized that the test results might be influenced by the examinee's reading or English language ability and developed the Beta test that was administered in pantomime. However, to understand the importance of literacy (i.e., reading) on the performance of language-mediated tasks on the Alpha, AGCT, or AFQT, it is necessary to take another approach. This approach draws upon the understanding of the developmental model that, in part, reading is the use of graphic symbols to access the same language competence that is used in auding. In this view, the written word is a second signaling system for speech. If the difficulties of less literate adults result primarily from an inability to decode and comprehend the written language efficiently, they should have little trouble decoding and comprehending this information when presented in the spoken language.

In research sponsored by the Air Force, the Literacy Assessment Battery (LAB) was developed to measure the comprehension of passages presented in written or spoken language (Sticht, 1978; Sticht, 1979a; Sticht & Beck, 1979). The passages were calibrated by both readability measures and magnitude estimation methods to be equivalent in difficulty. Following each passage, 12 constructed-response retention test items calling for near verbatim recall of factual information were administered. The questions following the auding passages were read aloud, while the questions following the written passages were read silently by the examinee. Time for reading the passages was limited to that required to present the spoken passages for auding. The idea was to determine if the person was as effective and efficient at comprehending by reading as by auding.

Following the passages of connected discourse, tests of vocabulary from the passages were administered. This was done to determine to what extent performance on the passage tests might reflect vocabulary knowledge. If less literate persons knew fewer of the words, this could lead to lower comprehension. Additionally, the vocabulary tests removed the requirement for the continuous processing of connected discourse. As indicated in the discussion of the human cognitive system, working memory is of limited capacity and it was anticipated that less literate readers might suffer from overload of working memory during both auding and reading of the passage tests. The vocabulary tests could reveal auding and reading differences with the load on working memory reduced. For each of the passages, a 14-item vocabulary test was developed using a multiple-choice format. The reading vocabulary test was presented for silent reading only. The auding vocabulary test was available in the written format so it could be read and was also presented aloud so it could be auded. This was done to determine whether there was a lack of vocabulary knowledge, not to determine an auding-reading gap.

A final part of the test involved a task in which examinees simultaneously auded and read passages that were presented at increasingly faster rates. The goal of this part of the LAB was to assess decoding ability. This part of the test is not particularly relevant to the present discussion, so it is not discussed here (see the references cited above for a discussion).

In a large-scale study, the LAB was administered to over 2,000 applicants for military service in 1978 (Sticht, Hooke, & Caylor, 1981). The applicants were also administered the 10 tests in the ASVAB, vocational battery, including those used to construct the AFQT, and either the Nelson-Denny Reading Test (N-D), the Gates-MacGinitie Reading Test (G-M), or the Basic Skills Assessment-Reading (BSA), a functional literacy test for secondary and adult students (see the cited work for a more complete description).

Figure 6, Appendix B, shows the average percentage of correct scores for the LAB passage and vocabulary tests at 10 levels of reading ability as indicated by the G-M reading test. Most examinees performed better on the passages by reading than by auding; only those at the second-grade level on the G-M performed better by auding than by reading. Performance on the vocabulary test exceeded that of the passage tests at every reading level. However, there was a strong correlation between vocabulary knowledge and performance on the auding or reading passages tests, with correlation coefficients in the .68-.81 range.

Interestingly, the simultaneous auding-reading vocabulary test produced the best overall performance, particularly for the least able readers on the G-M, though why this is so was not determinable from the available data.

Overall, the data from the LAB tests indicate that there was very little difference between performance in languaging by ear or by eye in this study. For the most part, those who performed poorly by reading also performed poorly by auding, and vice versa. Furthermore, those low in auding or reading passages were also likely to be low in vocabulary knowledge.

Interpreting Test Results in Terms of the Developmental Model of Literacy

According to the developmental model, the prelinguistic child of Stage 2 represents knowledge in nonlanguage forms and picks up new information through listening and looking (excluding other processes, such as touching, for the present purposes). This mode of representation is primarily perceptual rather than semantic and has been labeled by some as *imagery* or *analogic* or *spatial* (Marshalek, 1981).

In the model, the auditory and visual imagery adaptive processes develop first; they then transform to create oral language (listening changes to combine listening and languaging, or auding), and oral language, in turn, is integrated with looking skills to produce looking and languaging, or reading. According to this way of thinking, all reading test performance includes reading, languaging, and imagery. All auding test performance includes languaging and imagery. Tests such as the Space Perception subtest of the ASVAB can be taken as indicators of imagery. Of course, there are also task factors, such as the reasoning and special knowledge demands that influence actual test performance using literacy, oracy, or imagery tests. Further, the actual assessment of skills in tests such as those of space perception generally involve the ability to comprehend oral and written language to follow the test instructions, but performance on such tests is not as dependent on language as is performance on oracy and literacy tests.

Given the development sequence: imagery ---> oracy---> literacy, and using as indicators of these skills the Space Perception test and the LAB Auding (oracy), and Reading (literacy) Paragraphs, we can expect to find the Space Perception test least correlated with literacy tests, the LAB Auding Paragraphs correlated more highly with literacy tests, and the LAB Reading Paragraphs the most highly correlated with literacy tests.

Table 4, Appendix A, presents the intercorrelations of the ASVAB Space Perception test, and the LAB Auding and Reading Paragraph tests to each other, and to the various subtests of the standardized reading tests, and the subtests and composites of the ASVAB, as well as years of education.

The first column shows that Space Perception correlates .34 with the LAB Auding and Reading Paragraphs tests, indicating that, as suggested by the developmental model, imagery underlies and is involved in both oral and written language processing. The second column shows that the Auding and

Reading Paragraphs are fairly highly correlated (.73), as would be expected from the developmental model, the similarity of the attentional and semantic memory task demands, and the close temporal proximity in the assessment environment with the two subtests.

Education is more highly correlated with the Auding and Reading Paragraphs tests than with the Space Perception test as might be expected since one function of schooling is to systematically develop language skills. The fairly low correlations of education with Auding and Reading Paragraphs tests no doubt reflects the restricted range of education levels in the test sample and the over-representation (over 50%) of people who completed 12 years or more in a row of education.

The Attention to Detail (AD) subtest of the ASVAB could probably serve as another proxy for prelinguistic information-processing abilities, much as the Space Perception test is used in the present analysis. The slightly higher correlation of AD to the Reading Paragraphs test may reflect the fact that alphabetic letters are used in the AD task, and hence some slight relationship to decoding might be influencing the AD and LAB Reading Paragraphs correlation.

The relationships of LAB Decoding test total scores and the various vocabulary and paragraph tests to the Space Perception, LAB Auding Paragraphs, and Reading Paragraphs tests present a recurrent pattern that is consistent with the developmental sequence of imagery ---> oracy---> literacy. Across the eight columns, the data show that Space Perception has the lowest correlations, Auding Paragraphs the next higher correlations, and LAB Reading Paragraphs the highest correlations with the various literacy tests. The same pattern is found for the space, auding, and reading row tests with the various literacy test total scores and the GT composite from the ASVAB (far right-hand columns). On the average, the ASVAB Space Perception test correlated about .35, the LAB Auding Paragraphs about .63, and the LAB Reading Paragraphs about .73 with the various literacy tests.

The effects of special knowledge are indicated by the correlations between the three row tests and the ASVAB special knowledge tests. For six of the nine special knowledge tests, the pattern shows Space Perception with the lowest, LAB Auding Paragraphs the next highest, and the LAB Reading Paragraphs with the highest correlations with special knowledge, preserving the pattern found between the row tests and the various literacy tests. However, while the pattern is the same, the magnitude of the correlations is different, with Space Perception tending to have higher correlations, and the LAB Auding and Reading Paragraph correlations to shrink.

The latter findings are consistent with the developmental model in showing the effects of essentially two major kinds of processing skills, those that construct internal language from external language displays such as speech and writing, and those that are prelinguistic in origin and result in the construction of internal, nonlinguistic images from external information displays and task requirements. Among the types of tasks that result in the construction of internal images or spatial modes of thought are mathematics tasks. Concepts such as place value are essentially spatial. Mathematics tests require both language and spatial perceptual processing (Marshalek, 1981).

The Mechanical Comprehension (MC) subtest of the ASVAB shows the influence of space perception most dramatically. This test requires the examinee to mentally image and rotate gear assemblies to determine what the consequences would be of turning a gear or pushing a lever in a certain direction. As Table 4, Appendix A indicates, the Space Perception test correlates slightly higher with MC than do the LAB Auding and Reading Paragraphs tests.

The Learning Abilities Measurement Program (LAMP)

In 1986 the Air Force Human Resources Laboratory, now called the Armstrong Laboratory, initiated a program of research into the cognitive skills that comprise general learning ability (Payne, Christal, & Kyllonen, 1986). The program is called the Learning Abilities Measurement Program (LAMP).

A major outcome of the first five years of LAMP research was the formulation and validation of an architecture representing the human cognitive system that includes three basic components: a *perceptual system* that picks-up information from outside the head; a *cognitive system* consisting of a working memory that differs in capacity for different individuals and two long-term memory stores consisting of a declarative knowledge base and a procedural knowledge base; and a *motor system* for transforming thought into action (Armstrong Laboratory, 1991, pp. 5-6).

In addition to the architectural components, the framework includes the idea that there is an *information-processing speed* for the various processing systems (perceptual, cognitive, and motor) that leads to differences in the learning abilities of individuals. Additionally, individual differences are predicted by the capacity of working memory, the breadth of declarative knowledge, and the breadth of procedural knowledge. In a variety of learning tasks, including reading comprehension, this model of the cognitive system and its operating characteristics (capacity, speed) has accounted for 40-50% of the individual differences variance.

One of the conclusions from LAMP is that reasoning ability is predictable from tests of working memory capacity and vice versa. This means that improved reasoning ability may increase working memory capacity in a given domain of knowledge. In several studies, estimates of the correlation between working memory capacity and reasoning ability ranged from .80 to .90 (Kyllonen & Christal, 1990).

This relationship between reasoning and working memory capacity may underlie the ability of the Beta test used in World War I to assess intelligence. As mentioned earlier, the Beta tests appear to have drawn very little on declarative knowledge (language-mediated vocabulary, facts, semantic information), but rather to have involved attentive processes in looking and reasoning about the sequence of graphic displays. This would emphasize perceptual and working memory processes and some access and use of procedural knowledge for reasoning, but not much processing of information into or out of the declarative knowledge base.

Reaching a Consensus on a Model of the Human Cognitive System

There is a high degree of similarity between the model of the human cognitive system in Figure 1, Appendix B, and the model of the information-processing system established in LAMP. Similar models have emerged in the work of various military and civilian laboratories that study human cognition.

A military-sponsored conference in 1984 resulted in the recognition that while there is not a uniform acceptance of a human cognitive system model among all cognitive scientists, most research does involve the components described in Figure 1, Appendix B (Sticht, Chang, & Wood, 1986, p. 308). Most cognitive system architectural models include a long-term memory store or knowledge base and a short-term or working memory that operates on information from the knowledge base and from the external world by means of information sending and recording processes, such as speaking and writing (sending) and auding and reading (recording).

According to LAMP, a major factor contributing to the learning ability of individuals is the breadth of their declarative and procedural knowledge. The importance of this breadth of knowledge is revealed in the large manifold of positive correlations among spatial, auding, and reading tests and the various other literacy and special knowledge tests in Table 4, Appendix A. The information in that table shows that broad tests of general literacy are more highly correlated with each other than with the special knowledge tests. However, there are moderately positive intercorrelations of the broad literacy tests (Auding and Reading Paragraphs) with the special knowledge tests. This suggests that broadly literate people are also likely to know a lot about specific domains of knowledge, while narrowly literate individuals are not likely to possess knowledge in numerous special domains. However, the narrowly literate person may have a depth of knowledge in a special domain, such as automotive and shop information, that permits fairly high scores in that domain, changing the rank ordering of persons and lowering the correlation with the broad, general literacy tests.

The distinction between the breadth and depth of knowledge in literacy plays an important part in understanding the work on functional, work-related literacy training that the military has accomplished over the last half century. It will be discussed further in part 4 of this paper.

PART 3: ASSESSING THE COGNITIVE DEMANDS OF MILITARY JOBS

PREDICTIVE VALIDITY STUDIES OF THE COGNITIVE SKILLS DEMANDS OF MILITARY JOBS

The predictive validity approach is followed to develop information to be used in the selection of people to work in a given job or career field (e.g., clerical). This approach usually produces scores on a predictor test battery that are correlated with scores on some criterion assessment such as success in training (including completion), grades, or instructor ratings. Additionally (or alternatively), indicators of job proficiency after training may be used as criterion measures to which scores are predicted. These indicators may include supervisor ratings, peer ratings, job knowledge tests, job sample tests, and so forth.

The assessment of the cognitive skills of personnel has been one side of the predictive validity approach for determining the cognitive skill demands of military jobs. The ASVAB and other such tests are used to develop scores made up of various subtests (called composite scores) that are used to assign people to work that their skills match. These composites are validated by determining the extent to which scores on the tests are correlated with performance either in training or on the job. Cutoff scores on the assignment composites are then chosen to increase the likelihood that a given person will be successful in training and on the job. That is, a prediction is made from scores on the cognitive tests as to the probability that a person will be successful in a field of work. The prediction is checked, or *validated*, by finding out whether a person does or does not succeed in training or on the job. This general approach to determining the cognitive skills demands of a job illustrates the *predictive validity* method for determining the cognitive skills requirements of jobs.

The predictive validity method has been used by the armed services in developing selection and classification tests since World War II (see Table 1, Appendix A). As noted earlier, Congress has established a law that excludes from military service those who score below the 10th percentile on the AFQT because hundreds of predictive validity studies have indicated that those who score below the 10th percentile will not be as successful in training or on the job as those who score above that cutoff score (Wigdor & Green, 1991). Therefore, Congress has stipulated that time and money should not be spent trying to accommodate the least cognitively developed in the armed services.

As indicated in Figure 5, Appendix B, the 10th percentile on the AFQT translates roughly into a 4th- to 6th-grade reading level, a CASAS score of around 212, and an NAEP score in the vicinity of 235. This is only an approximate relationship because the NAEP data of Figure 4, Appendix B, are for the document scale, while the NAEP data of Figure 5, Appendix B, are for the reading scale administered to both children and adults. Given this caveat, the data in Figures 4 and 5 confirm that the least literate are restricted from military service. The significance of this is that it constitutes the only Congressionally mandated *national literacy standard* for entry level work in the United States.

Further, an NAEP score of 235 is below the 250 score which designates the lower skill level of the middle 50% of young adults who work as laborers (see Figure 4, Appendix B). This suggests that not only do the least skilled (as indicated by the AFQT) face limited opportunities for military employment, but they also have fewer opportunities for well-paying jobs in the civilian world of work.

The JPM Study of the Cognitive Skills Required by Military Jobs

The largest predictive validity study of the cognitive skills requirements of military jobs is the Job Performance Measurement/Enlistment Standards Project, or JPM (Wigdor & Green, 1991). The JPM was initiated in 1980 and completed in 1992. In this study, some $36 million was invested in developing measures of job performance to serve as criterion indicators of job proficiency. Over the decade, more than 15,000 troops from all four military services were involved and dozens of professionals in psychological measurement participated.

The project was originated as a consequence of a major error that was made in the calibration of the ASVAB during the period 1976-1980 (Sticht, 1992, pp. 54-64). In 1980, it was discovered that over 300,000 applicants who should have been rejected because of low cognitive ability were inadvertently admitted into the armed services. When the mistake was discovered, a series of investigations was initiated to discover how the *potentially ineligibles* (PIs) performed in training and on the job.

A detailed report of the ASVAB miscalibration and the studies that it stimulated is given in Sticht (1992, pp. 54-64). In summary, on measures of completion of the first term of enlistment, a general indicator of satisfactory performance in the military, studies showed that the PIs had completion rates for 36 months of service of 49%, 53%, and 97% for the Army, Air Force, and Navy, respectively. This compares to completion rates of 52%, 64%, and 95% for recruits who were eligible for service during that time (Sticht, 1992, p. 57, Figure 12).

On job performance measures, the Army administered Skill Qualification Tests (SQT) consisting of paper-and-pencil job knowledge tests, job sample tests in which actual job tasks were performed, and supervisor ratings. Analyses of SQT performance for PIs and eligible recruits of average cognitive ability (Mental Category III) were conducted for both high school graduates and nongraduates. The studies found that high school graduate PIs scored 59% compared to 63% for graduate eligibles. Nongraduate PIs scored 63% correct and nongraduate eligibles 64%. That the non-high school graduates scored higher than the graduates reflects the fact that the military has higher cognitive skill requirements for nongraduates.

In general, based on the various studies, the U.S. Department of Defense's (DOD) director of accession policy concluded this regarding the performance of the PIs:

> They completed training; their attrition rates weren't unusually high; they were promoted at rates only slightly lower than their higher scoring peers; and they re-enlisted. So, the question was not that training grades were somehow flawed, but that a quarter-of-a-million people who did not

> meet the enlistment standards and should not have been able to do the job did in fact do it pretty well. (Sellman, 1987, p. 420)

The mistake in the ASVAB calibration and the subsequent enlistment and generally satisfactory performance of hundreds of thousands of those whom the ASVAB had predicted would fail, led the DOD, with the endorsement of the Congress, to conduct studies to determine if better measures of job performance could be developed and used to validate the enlistment standards set.

The results, after a decade of research, are summarized in a volume produced by the National Research Council of the National Academy of Science (Wigdor & Green, 1991). In a summary statement, the Council states, "The [job] performance measures provide a credible criterion against which to validate the ASVAB, and the ASVAB has been demonstrated to be a reasonably valid predictor of performance in entry-level military jobs" (p. 5).

The subtests of the ASVAB are:

• Word Knowledge (WK)	testing vocabulary knowledge
• Paragraph Comprehension (PC)	reading brief paragraphs and answering questions
• Arithmetic Reasoning (AR)	solving word problems
• Mathematics Knowledge (MK)	solving problems involving geometry and algebra
• Numerical Operations (NO)	rapidly adding, subtracting, multiplying, and dividing
• Coding Speed (CS)	rapidly matching letter and number series
• General Science (GS)	questions involving knowledge of biology, physics, etc.
• Mechanical Comprehension (MC)	imagining the movements of cogs, gears, levers, etc.
• Electronics Information (EI)	questions involving knowledge of electricity
• Auto and Shop Information (AS)	questions about cars, tools and shop procedures

Adapted from Wigdor & Green, 1991, p. 157, Table 8-9.

The first four tests are combined to form the composite AFQT. Other subtests are combined to form special aptitude area (AA) scores. For instance, the Arithmetic Reasoning (AR), Word Knowledge (WK), and Paragraph Comprehension (PC) scores are combined to form the Army's general technical (GT) composite and the Air Force's general (G) composite. All the services use a composite of AR + GS + MK + EI to form an electronics (E) composite.

In the JPM project, the AFQT and various ASVAB composite scores were correlated with indicators of job proficiency. The central indicator was taken to be hands-on job sample tests (Wigdor & Green, 1991, p. 147). Additional indicators given special attention were paper-and-pencil job knowledge tests. (These are much easier to develop, administer, and score, and to the extent that they provide similar information as hands-on test performance, they represent cost-effective surrogates of the latter tests.)

The JPM study provides data that permit the determination of the extent to which specific job knowledge (paper-and-pencil tests of job knowledge), special job-related knowledge (aptitude composites derived from ASVAB subtests), and general knowledge (the AFQT) relate to the ability to perform actual job tasks.

The JPM study found that correlations of paper-and-pencil tests of job knowledge and hands-on job-sample test performance in nine Army, four Marine Corps, and three Navy jobs ranged from .35 to .61, with a median correlation of .47 and .59 when corrected for limitations in the reliabilities of both tests (Wigdor & Green, 1991, p. 151, Table 8-5). These data indicate substantial relationships between these two types of job proficiency indicators, but the relationship is far from perfect and one indicator cannot substitute for the other. In other words, a reading test that assesses specific job knowledge is not necessarily a good predictor of ability to perform job tasks.

The effects of special aptitude composites that typically combine one or more measures of general literacy, (e.g., word knowledge, paragraph comprehension, arithmetic reasoning), with one or more measures of specific literacy, (e.g., auto and shop information, electronics information) was also studied. These composites represent measures of job-related knowledge accessed via reading. For 13 jobs, the median correlation of the special aptitude area score with hands-on job sample test performance was .50, corrected for restriction of range (Wigdor & Green, 1991, p. 161, Table 8-10).

The correlations of general literacy (AFQT) with hands-on job tests in a sample of 23 jobs across the four military services ranged from a low of .10 (Air Force traffic control operator) to a high of .49 (Marine Corps machine gunner), with a median of .26. After correcting for the restriction in range that results from studying only those already experienced in the job, the correlations increased to .13, .67, and .38, respectively (Wigdor & Green, 1991, p. 160).

In this set of studies, by squaring the corrected correlations, the predictability of hands-on job sample test performance increased from 21% when general knowledge was the predictor, to 25% when both general and job-related knowledge were combined into AA composites, to 35% when job-specific knowledge was used to predict hands-on test performance. In all these assessments, reading in the sense of using the written language as a second signaling system for speech was common to the predictor tests. What appears to have made a difference, then, is the relationship between the knowledge base in the human cognitive system accessed via reading and the knowledge needed to perform the hands-on job tests.

Predicting Job-Related Reading Task Test Performance

Most jobs require that employees be able to read the technical manuals, procedural job aids, safety instructions, and other job-related reading material used in performing their jobs. Research sponsored by the U.S.

Army investigated relationships among the AFQT, a standardized reading test (the California Survey of Reading Achievement, Junior High Level), and a specially developed job-related reading task test (JRTT) in three Army jobs: cook, supply clerk, and vehicle repairman (Sticht, 1975, chapter 3).

Correlations for over 200 men who had completed job technical training were obtained in each job. It should be noted (see Table 1, Appendix A) that the AFQT in use at the time of the study included two subtests (Spatial Perception and Tool Recognition) that would lower the relationship between the AFQT and a standardized reading test. These correlations were .66 for cooks, .75 for clerks, and .78 for repairmen. The correlations of AFQT with JRTT performance were .54, .58, and .65 for cooks, clerks, and repairmen, respectively. For the standardized reading test, the correlations were .73, .70, and .65. Corrected for restriction of range, each of these coefficients would likely be increased by approximately .10. This would mean that the AFQT predicted 40% of the variance in JRTT performance while the standardized reading test predicted 64% of the variance in JRTT.

All of the foregoing correlations involved predictor and criterion tests. When the criterion indicator of job proficiency was changed to supervisor ratings, the correlations with literacy (paper-and-pencil aptitude) tests dropped precipitously—levels ranging from .06 to .17 in work reported by Sticht (1975, p. 67, Table 24) to a range between .12 and .15 in Zeidner's extensive review of the GATB and ASVAB (1987, pp. 44-48, Tables 13 & 14).

What this means is that general literacy tests are good, but far from perfect, as predictors of the ability to perform job-reading tasks. The further one gets from correlating reading-based knowledge assessments with similar criterion measures of job performance, the less accurate is the predictive validity of the cognitive assessments. In order of magnitude, when the JPM studies are considered, general literacy tests (like the AFQT, AA composites, and standardized reading tests) are best at predicting JRTT performance (40-64% of the criterion variance), second best at predicting job knowledge paper-and-pencil test performance (35%), third best at predicting hands-on job-sample test performance (21%), and least efficient at predicting supervisor ratings of performance (less than 2-3%).

Using the Predictive Validity Method to Establish Reading Requirements of Jobs

The predictive validity approach was used by Sticht, Caylor, Kern, and Fox (1971) to establish reading requirements for Army jobs that would enlist large numbers of lower ability personnel. In this work, standardized reading tests were administered to 400 personnel in each of three Army jobs: cook, supply clerk, and automotive repairman. Additionally, data were obtained on the three indicators of job performance discussed above: JRTTs, paper-and-pencil job knowledge tests, and hands-on job sample tests. The goal of the study was to establish reading requirements for Army jobs that could be used to set standards for military literacy training.

The setting of such standards is essentially a judgmental process: there is no technical methodology for setting cutoff scores on what are essentially continuous relationships among predictor and criterion tests. For example, Figure 7, Appendix B, shows the relationships between reading grade level, as measured by the California Survey of Reading Achievement Tests for the middle grades, and JRTTs for the three Army jobs at three different criterion levels of performance: 50%, 60%, and 70% correct.

Clearly, there is no one general reading level below which all are unsuccessful on the JRTT and above which all are successful. Indeed, the very definition of success is not specified by the empirical data. That is, should the criterion of success be 50% correct? How many people should have to reach that level? One hundred percent? If so, then for cooks, an 8th-grade general reading level would permit 100% of personnel to reach a criterion of 50% correct on the cook's JRTT. That would seem to be true for the repairman's JRTT also, if the curve for the 50% correct criterion between the 5th and 8th grades is assumed to increase gradually and the score for the 6th-grade general readers is spurious. Following this same decision rule, those entering the supply specialist's field would have to read at the 12th-grade level. This would permit 100% of personnel to reach the criterion of 50% correct on the JRTT.

In the project as it was actually conducted, it was decided to follow a decision rule consistent with the Army's criterion for a successful training outcome—80% of the students reach a grade of 70% correct on their course tests. Applying the 80/70 rule, the standard for literacy training for cooks was set at the 7th-grade level, for repairmen at the 9th-grade level, and for supply specialists at the 12th-grade level (Sticht, 1975, p. 57).

Regarding the relationships between reading and job knowledge and hands-on job performance tests, Figure 8, Appendix B, shows the quartile distributions at each reading grade level. The correlation coefficients are also given. As with the JRTT, there is no point along the reading scale below which all scored in the bottom quarter or bottom half on the job knowledge or job performance tests. Given that there is no obvious empirical or technical solution to the problem of setting standards of performance on the job knowledge and job performance tests, a judgmental rule must be established and followed.

In the study under consideration (Sticht, 1975, chapter 4), it was established that the reading level that should be the aim of a literacy training program should not be overrepresented in the bottom quartile of job performers. In the cooks' data, over 70% of those reading at the 4th- to 5.9th-grade level scored in the bottom quartile on the job knowledge test. It is not until the 7th-grade general reading level that fewer than 25% were in the bottom quartile. Therefore, following the specified decision rule, literacy training would be targeted at the 7th-grade level for cooks. Applying the same decision rules to the cooks' job performance test results, once again 7th-grade reading is associated with not being overrepresented in the bottom quartile of performers. Similar applications of the decision rule to the other job data leads to the designation of an 8th-grade level for literacy training for repairman and a 9th-grade level for supply specialists. Note that this ignored some rather egregious deviations from continuity. For example, only the expected 25% of those reading at the 4th- to 5.9th-grade level on the supply specialist's job knowledge test were in the bottom quartile. Such deviations were considered as sampling errors.

Using these applications of the predictive validity approach to identify the reading demands of jobs, it was recommended that the minimum goals for Army literacy training should be the 7th-grade level for cooks, 8th-grade level for repairmen, and 9th-grade level for supply specialists.

It is important to note that these decision rules were aimed at providing recommended standards for literacy training, *not* for screening people into or out of the military. All of the people tested were employed in the military at the time, and most, including the least literate, were performing satisfactorily. Clearly, setting standards for selection purposes would dictate different decision rules, and standards would not be set as high in order to avoid rejecting too many people who could, in fact, learn and perform jobs very well.

THE DEVELOPMENTAL MODEL AND THE PREDICTIVE VALIDITY APPROACH TO IDENTIFYING READING REQUIREMENTS OF JOBS

According to the developmental model of literacy (Figure 2, Appendix B), a person first learns through prelinguistic, perceptual processes; languaging emerges through auding and speaking; and literacy, considered as a second signaling system for oral language, is learned last. In this model, all languaging includes the knowledge developed prelinguistically and represented internally by perceptual processes (e.g., episodic memory), and all reading of prose includes both languaging and earlier prelinguistic knowledge. Following this line of reasoning, then, to the extent that job performance entails reading skills, there should be progressive increases in the correlation coefficients between measures of perceptual information processing and job performance, listening and job performance, and reading and job performance.

Research by Sticht, Caylor, and Kern (1971) permits an examination of the effects of adding language and literacy to prelinguistic learning. In that study, a maze test similar to that of the Army Beta (see Table 2, Appendix B) was used as an indicator of prelinguistic information processing. Two auding tests, involving comprehension and recall of orally presented prose passages and directions, were administered and served as indicators of languaging by auding. The Survey of Reading Achievement discussed above was used as the indicator of general reading ability.

These predictor tests were administered to the cooks, repairmen, and supply specialists discussed above. For the present purposes, correlation coefficients across the three jobs have been averaged. The average correlations of maze, auding, and reading with hands-on job performance tests were .17, .33, and .33. In this case, using auding to predict job performance improved the predictive validity over that of the maze. However, reading as a predictor of job performance added nothing to auding. This probably reflects the fact that while the job performance test used both perceptual and language-based information processing, at least in following directions, it made little use of reading.

This possibility was checked by examining the predictor tests in relation to the paper-and-pencil job knowledge tests as indicators of job proficiency. In this case, the average correlations were .17, .36, and .48. Thus, when the criterion of job performance inherently involved languaging by reading, reading was more highly predictive of job performance than languaging without reading (i.e., auding). Stated otherwise, when job performance is directly mediated by the use of reading, then reading will be a more potent predictor of performance.

This can be seen in Figure 9, Appendix B (Sticht, 1975, p. 54), in which the data for repairmen and supply specialists were further analyzed into three reading levels (predictor variables) and two criterion groups: those who performed hands-on job performance tasks and did not use the available technical manuals (black points), and those who did use the manuals (open points).

The data clearly indicate that those who used manuals performed better than those who did not, regardless of their reading level. Further, for those who did use manuals, the effects of reading ability are clear: better readers who used manuals performed better than less able readers who used manuals. In this case then, both having greater reading skills and using them increased job productivity as measured by actual hands-on, job sample performance tasks.

DISCUSSION OF THE PREDICTIVE VALIDITY APPROACH TO IDENTIFYING COGNITIVE SKILLS DEMANDS OF JOBS

The research reviewed on the predictive validity approach to identifying the cognitive skills demands of jobs is only a very small and narrowly selected sampling of such work in the armed services. Literally thousands of such studies exist correlating almost all cognitive (and hundreds of noncognitive) tasks imaginable to a wide variety of indicators of job proficiency. The review focused on the largest project yet undertaken to relate cognitive and noncognitive predictors to well-developed and thoroughly critiqued measures of job performance, the JPM project (Wigdor & Green, 1991). Additionally, the studies by the author and colleagues cited above form the largest corpus of research to directly investigate the relationships of literacy variables to job performance within the framework of a conceptual model of a human cognitive system, a model of literacy and its development, and an information-processing approach to cognitive performance, including learning.

Both the JPM and the earlier work by Sticht and associates indicate the following:

- The relationship of literacy to job performance is continuous, not dichotomous; that is, there is no empirical literacy gap to be found in these studies. Rather, they show that productivity on the job is a continuous function of literacy and other cognitive abilities incorporated within the literacy assessments.
- Generally speaking, the greater one's literacy ability, the more productive one is on the job, but this is a function of the criteria for job performance. The more the criteria incorporate literacy directly, as in performing job-related reading tasks, the greater will be the predictive validity of reading measures.
- The predictive validity approach requires human judgment regarding the types of predictor variables to be used, the criterion variables that serve as indicators of job proficiency, and the standards of performance desired on these criterion variables; *there is no completely empirical or technical*

method that can substitute for human judgment in setting these standards of performance. See the extensive discussion by Wigdor and Green (1991, pp. 207-210) in which they comment on a variety of very complex models for assessing human resources and using such assessments to set standards for allocating individuals to jobs. They state, "The solutions provided by such models are not intended to and will not supplant the overarching judgment that policy officials must bring to bear..." (p. 209).

- The purpose of the decision making determines the rules followed in setting standards for cognitive skills requirements. For instance, because of the relatively low predictive validities of literacy and other cognitive tests for predicting success on the job, decisions for setting standards of literacy that exclude people from job opportunities should follow different rules from those used to establish standards for literacy training. Generally, higher standards may be set for training because it will probably not harm people to receive training beyond what they might need as a minimum. But as the data reviewed above indicate, unreasonably high standards for entry into job training or employment may exclude from work thousands who could, in fact, perform satisfactorily in both the classroom and on the job.

JOB AND TASK ANALYSIS STUDIES OF THE COGNITIVE SKILLS DEMANDS OF MILITARY JOBS

Recent reports provide extensive reviews of job and task analysis methods for identifying the cognitive skills requirements of military jobs (Payne et al., 1992; Wigdor & Green, 1991, chapter 4). Payne et al. focuses on task analysis methods for identifying the basic skills (reading, mathematics) requirements of jobs to be used in the development of training programs. Their review includes a discussion of the methods used in developing the Navy Job-Oriented Basic Skills (JOBS) program and the Army's Job Skills Enhancement Program (JSEP). Both of these programs are reviewed later in this report.

Wigdor and Green (1991) discuss job and task analysis to identify job performance measures, such as the hands-on tests used in the JPM project. In addition to their discussion of methods for identifying job tasks, they describe several approaches to *trait* and *task-by-trait* analysis of jobs.

In trait analysis, analysts estimate the types of general abilities workers should have to perform various jobs or job tasks. Traits are relatively fixed characteristics of individuals, such as verbal and quantitative aptitudes, psychomotor skill, information-processing speed, interpersonal skills, and so forth.

Task-by-trait analysis uses a generic approach and a local approach. The generic task-by-trait analysis assumes that all tasks can be broken down into a set of general, generic human abilities. For instance, in one widely studied analysis, the generic traits include a general category called written comprehension. Tasks within various jobs that may fall under this category are: (a) understand an instruction book on repairing a missile guidance system, (b) understand an apartment lease, or (c) read a road map (Wigdor & Green, 1991, p. 83, Table 4-2).

Local task-by-trait analysis develops lists of generic skills as an emergent property of the task analysis. The methodology followed by the developers of the Army's JSEP program was an example of the local task-by-trait approach. Job tasks were identified through interviews with job holders and supervisors and a review of documentation about the job. Lists of job tasks were identified and then analyzed to identify the basic skills or prerequisite skills embedded within the tasks. This resulted in extensive lists of decontextualized basic skills, such as numbering and counting, vocabulary, reference skills, tables and charts, outlining, and so forth. Each of these categories contained additional categories of basic skills decontextualized from the tasks in which they were found. Altogether, 97 subskills in the quantitative domain and 56 in the verbal domain were identified (Hoffman, 1989, p. 6, Table 3).

In task analysis, for instance, a skill such as outlining is considered to be a general trait that a person can acquire that will then permit him or her to operate effectively in any context that requires the ability to outline. In the generic task-by-trait approach, lists of traits, abilities, or skills are developed and then used as an inventory to determine which skills are found in which tasks. In the JSEP program, the list of skills was only partially determined at the outset; additional skills were added to the list as they became evident during the task analysis. In some cases, the JSEP developers added lessons not directly derived from task analyses but that were considered as useful skills for soldiers to develop.

DERIVING POLICY, MANAGEMENT, AND CURRICULUM INFORMATION FROM TASK ANALYSES

A difficulty with the task analysis method of identifying the skills demands of jobs is that it is likely to produce extensive lists of tasks and their associated skills and to amass a monumental amount of job materials. While such information and material are necessary for curriculum developers, policymakers and managers find such lists and stacks of materials overwhelming. They prefer some summary index that expresses the general level of skills needed so that they can set policies for selection and program outcomes. One example is the use of the 10th percentile on the AFQT as the minimum basic skills level for entrance into the armed services. A civilian example is the federally sponsored Job Opportunities and Basic Skills program for welfare recipients, which emphasizes a general goal for basic skills comparable to that of a student in the 9th month of the 8th grade (Chisman & Woodworth, 1992, p. 5).

A project that both developed a general summary index for the level of literacy required of jobs and identified reading tasks and materials for curriculum development was the Navy's Project SEAREAD (Sticht, 1977,1979b; Sticht, Fox, Hauke, & Zapf, 1976). The methodology developed in this project was used by Mikulecky and Diehl (1980) in an adapted form to study the reading requirements of some 100 civilian jobs, and it served as the forerunner to what is currently called *literacy task analysis* or *literacy audits* (U.S. Departments of Labor & Education, 1988).

The SEAREAD project was conducted to assist Navy training specialists in identifying the extent of reading difficulties in the Navy, to determine the need for reading training in the Navy, and to design plans that could be used to develop a training system that would integrate both job technical and reading skills training. The project accomplished the following:

- Studied the Navy's existing delivery system for remedial reading, job technical skills training, and career counseling as part of the project's aim to design a new, integrated system of reading and technical skills training.
- Studied the need for reading instruction through the development of the Navy Job Reading Task Interview which was administered to 178 students and instructors in recruit training, students and instructors in job skills technical training programs, and job performers aboard two classes of ships.
- Developed prototype Navy Reading Task Tests and a Navy Job Reading Task Inventory.
- Designed an integrated training and education system that incorporated reading development into technical training. The design included a prototype curriculum for a program that would take place between recruit and technical training to prepare undereducated students to enter into the technical school program.

For this discussion of task analysis, the second and third activities listed above are of primary interest. The Navy Job Reading Task Interview provided several types of information, including general reading and writing tasks performed by Navy personnel and the amount of time spent at these tasks, job reading tasks, and attitudes toward reading and job skills training in the Navy.

The structured interview obtained information for the Navy job reading task categories identified in Figure 10, Appendix B. First, the sailor was asked to identify a job task that he or she had been doing in which some reading material had been consulted. Previous research suggested that job-related reading consisted primarily of *reading-to-do* and *reading-to-learn*. In turn, these two types of reading tasks represented the importance of the working memory and long-term memory as given in the human cognitive system (Figure 1, Appendix B).

In a reading-to-do task, the sailor in the middle of a job task decides that information is needed, looks up the information in a manual or document, holds the information in working memory, applies it, and then can forget it. In this way, reading-to-do tasks emphasize the importance of being able to control information processing in working memory. In reading-to-learn, on the other hand, the person reads information into working memory and then processes it for storing in his or her knowledge base of long-term memory. In the Navy Job Reading Task Interview, an attempt was made to identify one reading-to-do and one reading-to-learn task from each of the 178 personnel interviewed. Additionally, based on the developmental model's emphasis upon the role of contextual and prior knowledge on reading comprehension, the interview included a series of questions to illuminate the knowledge contexts in which the specific reading task took place. This included information about prior experience with the job task and the job reading materials used.

Finally, information processing was studied by observing how well personnel searched for information when they were identifying the parts of manuals that they said they read for reading-to-do tasks. Also, they were asked to identify the information-processing strategies that they used to learn materials when reading-to-learn. To identify whether the personnel understood the functional context for their reading, they were asked questions about their expectancies for using the information gained by reading (i.e., would or did it help them perform a task; did they think what they were learning would be of use to them later on).

Altogether a total of 325 reading tasks were identified; of these, 60% were reading-to-do and 40% were reading-to-learn. For the most part, job incumbents reported that reading-to-do made up the bulk of their reading (75%). Students in training, on the other hand, reported about half reading-to-do and half reading-to-learn.

Of the 325 tasks, 32% involved reading textual materials only, 25% involved only the use of figures, and 37% involved reading and using both texts and figures. Thus, 62% of the reading tasks involved the use of figures. This means that the use of readability formulas for estimating the reading demands of jobs is of limited value. Such formulas do not specify the reading level of figures. (For a complete account of the findings from the Interview, see Sticht, 1977).

The tasks and materials identified in the job interviews were used to develop job reading task tests. Because the interest was in identifying job requirements, and 60% of the tasks reported by job holders were reading-to-do, only reading-to-do tasks and materials were used. The types of questions identified in the interviews indicated that only two types of information were sought in reading-to-do: either the materials were used to locate a significant fact or set of facts to be used in accomplishing a task, such as finding the specifications for a meter reading in equipment repair; or the materials were used for the procedural directions to do a task.

For this reason, Navy Job Reading Task Tests were constructed that used *Bluejacket's Manual* for recruits as the principle source of materials. This was done because the aim was to determine the level of general reading associated with performing Navy reading tasks of those with little experience in the Navy. One of the reading tasks, locating facts using texts and tables, is illustrated in Figure 11, Appendix B. When it was administered to 6 sailors who read at the 6th-grade level on a general reading test (the ND), 83% answered the question correctly. Following the arbitrary decision rule that 80% of personnel should be able to perform a given Navy reading task, this item would be assigned a reading level of the 6th grade. Using this same approach, 33 items were scaled for difficulty, including some that involved reading just figures. This provided an estimate of the reading level of this type of complex task that readability formulas did not provide.

The 33 items scaled for reading difficulty were then used to develop a Navy Job Reading Task Inventory, as illustrated in Figure 12, Appendix B. In administering the Inventory, personnel were asked to answer the questions as indicated in the figure. They were told to ignore the specific contents and consider whether they do that type of task, not that particular task.

When the item was administered, personnel in four Navy jobs gave different frequency ratings. This suggests that the personnel were able to focus on the type of tasks, and not the specific content, and that different jobs do involve different tasks.

With the Navy Job Reading Task Inventory, then, one can identify the types of tasks job incumbents perform. This can be useful in designing curriculum materials that represent the types of tasks identified as being critical for job performance.

Because each Inventory item has an associated assigned reading difficulty level (even those that involve the use of both texts and figures or texts and tables), the general reading level of the job can be estimated by finding the average reading difficulty of the items in the Inventory weighted by their frequency and criticality. This general reading level can then be used by policymakers and training management to establish general goals for literacy training in job-related reading programs.

PART 4: WORKPLACE LITERACY PROGRAMS IN THE MILITARY

During World War II and up to the present, several military literacy programs have been developed that deliver instruction in the context of job-related military literacy tasks. Table 5, Appendix A, lists five such major military workplace literacy programs developed and conducted by the Army, Navy, and Air Force since 1943. These programs all follow what has been called a *functional context* approach to literacy training (Sticht, Armstrong, Hickey, & Caylor, 1987), that is, training is within the context of job literacy requirements. Instead of learning to read and write, for instance, through poetry, literacy is learned through the reading of military job manuals and writing letters to relatives (a morale builder) or writing instructions related to job duties.

WORLD WAR II

The literacy programs of World War II were the first major applications of functional context teaching methods for literacy training, though the developers of those programs did not refer to their methods as functional context teaching. They did, however, refer to the functional literacy needs of recruits. Military documents of the time specified that the reading curriculum of the Special Training Units be "completely functional and related to military life" (U.S. Department of the Army, 1965, p. 83).

Materials such as *The Army Reader*, published in 1943, emphasized Army life and language to aid a soldier's adjustment. In prose that gradually increased in complexity, the book told about Private Pete's day-to-day life. A later text, *Men in the Armed Forces* (Hardy & Burr, 1944), started with Private Pete on his farm and followed him to the recruitment station, then on the train to the camp, and through his successful adjustment to the Army. Because most of the literacy students were from rural areas, most students brought *prior knowledge* to the literacy learning task. Consistent with the developmental model of literacy and the human cognitive system discussed earlier, *Men in the Armed Forces* built on the predictable prior knowledge of its users. A second volume, *Army Arithmetic*, "was geared to military situations and presented material flowing from concrete to abstract" (U.S. Department of the Army, 1965, p. 83).

The Navy also used a functional approach to literacy instruction during World War II. In the Navy's Special Training Program, materials similar to those of the Army were developed, though Sailor Sam served as the central character. According to Fletcher (1976),

> Four basic assumptions...determined the focus of the Special Training Program....First it was a training program for adults. Although unable to read and write, the trainees came to the Navy having a command of a well-established oral vocabulary, together with a period of experience that put them beyond the appeal of grade school readers. Second, the trainees were the products of a wide variety of environments, so that the only interests they could have in common would grow out of their life in the services. Third,

> the limitations on time allowed for acquiring literacy made it mandatory that the program be rigidly functional in nature. A nominal grade of 5.0 in reading and writing was established as the teaching goal, but the purpose behind the program was simply to qualify men to read, write, and figure sufficiently well to perform all essential Navy duties. Thus, it was expected that graduates of the course would be able to read watch lists and safety precautions, and would be able to fill in beneficiary slips and small store chits.(p. 75)

Finally, Fletcher noted that the adequacy of instructors was assumed to be low, and therefore, the need for special materials that would produce the type of analytic and synthetic skills was thought to be necessary for seamen. The result was a series of workbooks, modeled after the *Camp Life* series of the Civilian Conservation Corps, which were used as the model for the *Army Life* and *Navy Life* materials. In the *Navy Life* Books I and II, recruits were taught to read in the context of barracks life and such naval subjects as semaphore, fire fighting, elementary navigation, naval customs, guns, ships, seamanship, personal hygiene, and naval terminology.

Evaluation of the World War II Literacy Programs

The work of the Army's Special Training Units has long been pointed to as an example of how adults can rapidly acquire functional literacy levels in short-term literacy programs (Robinson, 1966). However, much of this optimism appears to be the result of a misunderstanding of what exactly was accomplished in the Army and Navy programs.

The Army and Navy materials were not aimed at improving general literacy skills to any significant extent. Rather, the materials and instruction were aimed at improving recruits' literacy within a specific domain, that of military life. Although the materials were divided into grades, the Special Training Unit Tests for adults were not equated with those used by children.

> Even if grade norms were perfect indices, it is certain that norms on reading materials prepared for children aged 6 to 10 (first through fourth grade) would have been inapplicable to the illiterate adults in the special training program. The functional material prepared for adult illiterates in the Army were vastly different in content from typical primary grade reading materials and consequently, their organization and gradation were based on comparable, but different, criteria. (Goldberg, 1951, pp. 280-281)

The effectiveness of the training units in improving the general reading ability of marginally literate men is not clear; later military research suggested that short-term literacy training rarely made large, permanent changes in soldiers' general reading abilities as measured by standardized reading tests such as those used in the assessment of reading in the public schools (Sticht, 1982, pp. 21-23). The training programs were of short duration; hence there was little opportunity for overlearning of skills to produce the automaticity of decoding in reading that is discussed in the developmental model of literacy.

Although nearly 80% of those who graduated from the literacy programs after mid-1943 required 60 days or less to achieve the 4th-grade literacy standard for graduation, 45% of the entering trainees already read at the 3rd-

or 4th-grade level (Goldberg, 1951). The entering grade level of skills of recruits no doubt contributed to the success of the program; for the most part, recruits in the programs were not totally illiterate, and hence they possessed latent skills that could be exercised and developed more rapidly to achieve the fairly low standards of the programs (Cook, 1977).

Another factor that distinguishes the World War II literacy programs from literacy development in public schools or civilian adult programs is that the military programs had highly circumscribed goals and the materials tailored to achieve them. For instance:

> The content validity of the [Special Training Unit Reading Mastery] tests was established by basing them specifically on the *Army Reader* and the *Army Arithmetic*; the tentative critical scores established on the unit tests were determined by the staff members who had constructed the tests and developed the instructional materials; and...the critical scores represented the degree of accomplishment necessary for the work of the next level. (Goldberg, 1951, pp. 278-279)

Thus, rather than designed to produce broad knowledge bases, the military programs of World War II were designed to focus upon developing skills within a relatively narrow domain.

Additionally, the context of the training must be considered in determining the effectiveness of the programs. One of the reasons the armed forces felt compelled to accept low literates for induction was their need for manpower during a critical mobilization. While there was general agreement that some sort of remedial training was necessary, the goal was always to expedite men in and out of the Special Training Units. For this reason, it has been speculated that some Special Training administrators may have felt constrained to issue reports that, to some extent, exaggerated the success of their units. Hence, the Army data on performance may be flawed (Cook, 1977, p. 55).

Literacy and Performance During World War II

The low-aptitude, low-literate men who entered the military's literacy programs during World War II brought with them a number of similar characteristics. Many had been laborers or did farm-related work. Most had some education but came from backgrounds where reading was not essential to making a living. Few had police records. In general, the vast majority had demonstrated successful adjustment to life as civilians. Once inducted, they were given special literacy training to make them more useful and to facilitate their transition to military life. Following graduation from the Special Training Units, they were trained and assigned to jobs. Although their performance was often not as good as that of average-aptitude servicemen on several criteria, it was satisfactory, and much of the success can be attributed to the military's literacy programs. Yet, as discussed earlier, the results of the program must be evaluated with some caution. In short, while it is undoubtedly true that the Army and Navy literacy training programs improved many servicemen's reading abilities, the improvement was probably more limited than is generally believed.

Research conducted for the Navy (Hagen & Thorndike, 1953) attempted to measure the effects of the World War II literacy training on job proficiency. In this research, low literates who received literacy training were compared with literate men from the same parts of the country who also entered the military in 1944. The low literates were also compared with marginal-aptitude men who did not receive literacy training. It was found that the low literates who received literacy training had fewer promotions, lower proficiency ratings, more disciplinary problems, and fewer honorable discharges than either of the comparison groups. Thus, in this study, the literacy training was not found to produce men comparable in job proficiency to those with marginal or average aptitude.

However, the study had methodological limitations that suggest caution in accepting the conclusions as definitive. For instance, the average-aptitude group contained only draftees, no enlistees; the marginal-aptitude group was superior in literacy, general intellectual ability, and education level to the low-literate group who received literacy training; the marginal-aptitude group differed in age and background from the low-literate group; and in many instances, case records were incomplete and inconsistent.

In summary, while there can be little doubt that the World War II literacy programs successfully taught hundreds of thousands of personnel to read, write, and compute, several factors need to be noted:

- Though grade levels of achievement were given as objectives, the materials and contents of the military literacy courses were not truly as general and encompassing as the materials children learn from in elementary school and at home. Fourth- or fifth-grade reading in the military programs was not the same as fourth- or fifth-grade reading in the public school system.
- Hundreds of thousands (45% of the Army students) entered the programs just below (or already at) the objectives for the program and were retested and sent on to regular duty as successes of literacy training. Similar practices were found 25 years later in the Army literacy programs of the 1970s, suggesting that much of the success of military (and civilian) literacy programs might be attributable to *warm-up* or test artifacts such as regression to the mean (Sticht, 1975, p. 121).
- Unlike GED programs of adult literacy training, the World War II literacy training was not oriented to progression through the elementary and secondary school subject matter and skill development, despite the references to grade levels. Rather, the military programs were functional context programs that used contents (words, paragraphs, pictures) that related to (a) the civilian background knowledge of the entering recruits, (b) knowledge developed in transitioning from civilian life into military service, and (c) the needs of servicemen at their duty stations and in their Army and Navy lives.

An unfortunate consequence of the fact that the World War II literacy programs stated their objectives in grade levels was that it led many educators, including some directly involved in the programs, to believe that illiterate adult students were taught to read, write, and compute with the proficiency of children in the fourth or fifth grades, sometimes starting from zero reading ability, in a matter of 12 weeks or so.

The grade-level designation also had the effect of decontextualizing the functional context of the literacy programs and substituting, instead, the academic contexts of literacy training in the mode of the public schools in which the specific contents used to teach literacy are not considered important. Rather, the reading (and writing) skills are viewed as content-free grade levels of *skill*, not knowledge.

This academic view of literacy training came to dominate military literacy programs initiated in response to the mobilizations of the Korean and Vietnam Wars. This general literacy approach was also predominant in the late 1960s and early 1970s when research on the development of new literacy programs was initiated to accommodate what was expected to be the low skills of personnel entering the military under the new, all-volunteer military. This new research was based, in part, upon the findings of extensive research into the effectiveness of general literacy programs in the 1950s (Goffard, 1956). In one project, men who scored below the 4.9 grade level of reading on a standardized reading test were given special literacy training. They were graduated from training upon achieving the 4.9 grade level. When compared with similar control groups (i.e., marginally literate men who did not receive literacy training), the literacy students did perform slightly better on job performance and job knowledge tests given at the end of basic training. Differences in these test scores were less than 5% and were not considered by the researchers as of any practical value.

Additional studies to evaluate the effects of general literacy training on job proficiency in the military are reviewed in the book, *Marginal Man and Military Service* (U.S. Department of the Army, 1965). The upshot of these studies is that, at the end of the 1950s, little benefit to job proficiency had been demonstrated to result from the training in general literacy.

THE FUNCTIONAL LITERACY (FLIT) PROGRAM

Based on the research on the literacy demands of work and the shortcomings of brief, general literacy programs, the Army in 1971 sponsored the Functional Literacy (FLIT) project to develop a program that would provide a level of functional literacy appropriate to job reading requirements.

The FLIT program was the first adult literacy program to be developed based on concepts from cognitive science. These concepts included a psycholinguistic theory of reading and an information processing theory of learning. Regarding the psycholinguistic nature of reading, the 1971 planning document for FLIT states:

> Our approach to reading defines reading as a *psycholinguistic* process, i.e., a process involving the combined activities of fundamental psychological processes (perception, cognition) and linguistic processes (phonology, grammar, semantics). The psycholinguistic approach to reading emphasizes a developmental sequence in the

> acquisition of reading skills. (Human Resources Research Organization, 1971, p. 2)

The information-processing approach to learning was expressed as follows in the FLIT planning document.

> The information processing approach to learning emphasizes internal mental processes involved in learning. It views the person as an active, adaptive organism busily ordering and arranging an internalized representation of the life space. According to this view, learning is the resultant of an active, constructive process on the part of the learner. This differs from a strict behavioristic conception of learning in which learned responses are the result of some automatic process of association among stimuli and responses.
>
> The information processing approach to learning stresses internal strategies for dealing with information, such as the use of imagery or mnemonic devices to aid in learning a list of words. Thus, the information processing position would lead us to seek different internal processing strategies even though certain stimulus-response sequences may be the same. For instance, interest would focus not only on whether or not a problem is solved, but also upon how it was solved. It is thus analytic, stressing the detailed analysis of tasks in regard to the mental operations involved.
>
> For the FLIT developmental program, the most important aspect of the information processing approach to learning is the stress upon the *active, construing* nature of the learning process. This means that instruction must stimulate active information seeking and processing, particularly of the type thought to be important to job-related, functional literacy skills, e.g., learning how to locate information in job manuals, how to follow procedural directions in a manual, etc. This approach is consistent with an emphasis upon cognitive processes operating between input and output of information.(p. 3)

Objectives of FLIT

Army management stipulated that the FLIT course should be no more than six weeks, with students attending six hours a day. Furthermore, though the FLIT team had earlier developed job-related reading task tests to measure recruit literacy in functional terms, Army management required grade-level indicators of skill improvement. Accordingly, the FLIT objective was specified to be that of producing students *capable of using job reading materials with the effectiveness of a person having a general reading level of grade seven or higher.* This objective was determined to be the lowest level for literacy training given the requirements for literacy (described earlier in this report). The objective of the Army's general literacy program, which the FLIT program was to replace, was the 5th-grade level in general literacy.

To achieve the FLIT objective, the job-related reading task tests were scaled in grade levels by administering them to several hundred personnel along with a standardized reading test. The grade-level norms for the standardized tests were then used to determine what the average score on the job-related reading task tests were for those scoring at each grade level on the general reading tests. With this information, it was possible to indicate that a person who scored a certain percentage correct on the job-related reading task test scored at a general reading grade level.

The next step was to develop job-related training that used the content and materials from Army jobs to teach reading skills. As indicated by the human cognitive system model and developmental model of literacy earlier in this report, and the intercorrelations among cognitive tests and the LAMP project reviewed earlier, people must have some considerable prior knowledge to read and comprehend in a given content area, such as a technical job. For instance, personnel who score high on tests of general reading ability do so because they have higher levels of vocabulary, and they know a lot about a wide variety of subjects. For this reason, personnel with higher levels of general reading are able to draw on their broad-based prior knowledge for reading and learning from job training materials.

However, it is also the case that it takes a long time to develop such large bodies of knowledge. By definition, it takes the typical student twelve years to acquire 12th-grade reading skills. If adults need to learn to read job materials and they have only a limited amount of time, as in the case of the Army's program, it is not possible to develop large bodies of general knowledge that will help them. However, by focusing the reading training on the contents and learning demands of the job field for which they are being prepared, it is possible to develop a fair amount of competence in both reading skills and job knowledge in a brief period of time. This was the basis for the FLIT program.

The FLIT program developed literacy programs for personnel with low reading skills who were assigned to become cooks, automobile repairmen, communications specialists, medical corpsmen, combat specialists, and supply specialists. To develop the programs for each of the job domains, it was necessary to determine the goals or objectives for the programs, develop assessment instruments to measure improvements in job-related reading, and design and develop the job-related reading curriculum.

Goals for Entry and Exit

The goals of the job literacy program were established in terms of:

- *The specific job reading tasks inherent in learning and performing the job.* These tasks were used to develop job reading task tests for measuring job reading skills on entry into the program and at the end of the program (pretest and posttest measures) and for developing the reading instructional materials.
- *Correlations among general reading skills and measures of job proficiency, including job knowledge and job sample test performance.* These correlations were used to identify the lowest general reading level that was associated with *not* being over-represented in the bottom quarter of performers on the job knowledge and job sample

performance tests. This criterion identified the 7th-grade level of general reading as the minimum for job-related reading in the FLIT program.

- *New recruits who performed below the 6th-grade level on a general reading test three times in succession, with two-week intervals between testings, qualified for the FLIT program.* This assured that only low-literate personnel would be admitted to the program. In addition, personnel had to score below the 7.5 grade level on both the general and the job reading task tests during in-processing into FLIT to remain in the program. This requirement was established to account for errors in estimation of reading skills due to fallible test instruments.

Although specific job-related reading training was developed for six different career fields, only three alternate forms of job-related reading task tests (JRTT) were developed with subtests sampled from different job domains. This meant that although, for instance, a soldier designated to be trained as a cook studied the cook's materials in the reading program, he was tested on a JRTT that might contain materials dealing with automotive repair, medicine, and so forth. This was done to provide an estimate of the generalizability of the job-related reading training from one job field to another.

It was anticipated that such generalization would occur for two reasons. First, special computer analyses were conducted with samples of textual materials from the six Army career fields. These analyses counted the number of words in a 150 word sample that were on the Dale-Chall list of 3,000 common words. The words that were not on the list of familiar words were counted and taken to be job-specific words. As Figure 13, Appendix B, indicates, almost three quarters of the words in the Army job materials were general and one fourth were job-specific. It was thus anticipated that the reading of job-related materials would improve word recognition of both general and job-related words.

A second reason for expecting generalization lay in the fact that much job reading involved the development of skills in using special graphic tools such as tables of content, indexes, and forms. Such formats are similar from one job to another in the military, and it was anticipated that practice with these formats in one job domain would generalize to similar formats in others.

THE FLIT CURRICULUM

The FLIT curriculum consisted of two activity strands: *reading-to-do* and *reading-to-learn*. The reading-to-do strand taught personnel how to use their manuals as reference materials. Research on Project SEAREAD had indicated that three quarters of work reading tasks involved looking up information to accomplish some job task. In reading-to-do tasks, the person does not have to learn the material; just locate, extract, and use it to accomplish a given task.

Figure 14, Appendix B, shows the sequence of reading-to-do instructional modules that were developed for each of the six Army job areas. Some job areas (i.e., communications, combat specialists, clerical, and automotive repair), included more than one specified job. For example, communications included wireperson, radio operator, and other similar jobs. Thus, one job-related reading program addressed this cluster of jobs.

The five modules in the reading-to-do strand included how to read and use tables of contents, indexes, tables, and graphs found in the job materials; how to locate and read specifications, and so forth in the body of a manual; how to read and follow procedural directions; and how to complete job forms using the information in the manuals and on the forms themselves.

Each module was preceded by a pretest which, if passed, permitted the person to move on to the pretest for the next module. If the pretest was failed, the person entered the module, completed 10 self-study worksheets, and took a posttest. If the person failed the posttest, a second set of 10 worksheets was completed and a different version of the posttest was taken. This time, regardless of whether or not the posttest criteria (90 or more correct in 20 or fewer minutes) was reached, the person was moved on to the next module to ensure that each student spent some time on each module.

The worksheets were developed following two general guidelines: first, ask questions that will guide the student's attention to the structure of the job reading materials, then to the content; second, arrange the exercises on the worksheet so that they go from simple to complex. For instance, on the first worksheet in the Table of Contents questions included: How many chapters are in this manual? How many sections are in chapter 1? How many paragraphs are in section II of chapter 3? These types of questions guided the student to form an understanding of the manual's structure and how it could be used to locate information. Subsequent worksheets started with the content of the table of contents:

> The types of facilities are discussed in chapter ________? The U.S. Army medical laboratories are discussed in paragraph __________, page __________? By starting with literal references to content and then introducing paraphrased statements, the questions progressed from the simple to the complex. "Where would you find Army activities in various regions for having your teeth worked on? chapter _________; section _________; paragraph __________; and page ________.

The reading-to-learn curriculum strand of the FLIT program differed in several significant ways from the reading-to-do. While the reading-to-do strand was an individualized, self-paced, mastery-oriented instructional sequence, the reading-to-learn strand was a teacher-oriented, group-paced, open-ended program designed to help students work together in teams and as individuals to comprehend and learn from training materials and job manuals.

We know from the model of the human cognitive system that people must be prepared in at least two ways for reading to learn: they must have the knowledge base to comprehend the material to be learned, including knowledge of strategies and methods for studying materials and relating what they read to what they already know; and they must possess the information-processing skills involved in encoding the written language into meaning.

Because the FLIT students were not at the lowest levels of literacy, the program focused on the development of a relevant knowledge base that would help students learn better from their job training materials. The reading-to-learn curriculum included specially developed materials that were written at a lower reading difficulty level (e.g., 9th instead of 11th-14th grades) and incorporated the basic concepts and topics within a given job training program. The basic concepts for the six job fields were identified through the study of job skills training program curriculum guides, and materials and consultation with job training instructors. For each job field, 12 major topic areas were identified, and specific knowledge objectives were developed for each area.

For each of the 12 job topics, a 300-400 word passage was written that included the knowledge objectives for the topic area. The passages were written without the redundancy and elaboration typical of textbooks because in the reading-to-learn activities the students performed repeated readings of the materials, sometimes alone and at other times in teams, to produce their own elaborations of the information in the passage. For instance, as illustrated in Figure 15, Appendix B, a medical corpsman trainee would be assigned to read the topic passage on first aid and to then draw pictures illustrating what the written passage said. Next, the student would study the passage again to prepare a flow chart of the four lifesaver steps in first aid.

Students were also engaged in reading passages that contained types of equipment, their uses, advantages, disadvantages, and so forth. The students then constructed tables (matrices) with columns, rows, and cells that could be filled in using the content of the passage. Through these *representation transformation* activities, students performed multiple readings of texts and elaborated them by constructing pictures, matrices, or flow charts. The activities required that the new knowledge in the passages be mixed with the student's prior knowledge for full comprehension to occur.

To help students learn to analyze the passages, simple grammar was taught which emphasized that all sentences consist of a main idea and more about the main idea—more about who, what, when, where, why, and how and more about the subject of the sentence. Exercises from the passages were developed to help students parse the sentences using the simple grammar.

For students with very poorly developed word recognition skills, individual vocabulary exercises were developed that included drill on recognizing the written versions of words that were either already in the student's speaking vocabulary, or which were taught by the instructor and then practiced by the student in reading aloud activities.

In practice, students worked in the opposite sequence from that discussed above. That is, first work was given at the word recognition level, then at the sentence parsing level, and finally in parsing the entire passage into pictures, matrices, or flow charts. Not all students required extensive work at the first two levels, so they moved quickly to the passage analysis tasks.

In addition to the job-related material, the FLIT schoolhouse had available a small library of paperback books, newspapers, and general adult basic education materials that students could read on breaks during the six-hour training day.

Evaluation of the FLIT Program

Achievement data for the FLIT program included pretests and posttests for each of the reading-to-do modules and data on both general reading tests and job-related reading task tests. The module test data are given in Table 6, Appendix A, and indicate considerable improvement in the earlier modules and less improvement in the later modules. This reflects the fact that the tasks in the later modules became more difficult, and more time was required for the less able students to work their way through the entire set of modules.

As shown by the data for Fort Ord in Figure 16, Appendix B, the FLIT reading program produced three times the amount of gain in job-related reading than it did in general reading: 21 months versus 7 months. It made more than three times the gain in job reading skills as the regular Army six-week general literacy programs in place at the time. It also far exceeded the gain in job reading skills made in a thirteen-week Air Force general literacy program. This is important because both the Army and Air Force general literacy programs aimed to improve personnel skills in reading military job materials; yet, the use of general literacy materials brought about only minimal improvements in job-related reading.

It should also be noted that the FLIT program's seven month gain in general reading ability was equivalent to what most Army general literacy programs achieved. Thus there is much more transfer from job-related reading training to general literacy than there is the other way around.

Retention of Literacy Skills

To examine the retention of end-of-course reading gains in both general and job-related literacy, 97 students were followed-up 8 weeks later and retested. On the general reading test, the students in the FLIT program had gained 10 months from pretesting to posttesting. Eight weeks later, however, only 40% (4 months) of this gain was retained. In job-related reading, students had gained 24 months, and 8 weeks later they retained 80% (19 months) of this gain. Thus, not only was job-related literacy training more effective in increasing job reading skill, but the newly developed skill was also retained better as the students applied what they had learned in the literacy program to their job technical skills training.

FLIT Implementation

Based on the demonstrated effectiveness of the FLIT program, Army management decided to implement the program at all Army training centers that were offering general literacy training. As Figure 16, Appendix B, shows, the results obtained at Forts Knox, Jackson, Polk, Leonard Wood, and Dix were essentially the same as those obtained at Fort Ord, where the FLIT R&D project was housed. At each site, the FLIT program led to greater improvements in job-related reading skills than that of the Army's General Literacy Program. At each site improvements were made in general literacy, but the greatest improvement was in job-related reading.

The job-related reading task tests measured generalization of job-related reading, and the general reading tests showed improvements. This indicates that, contrary to what some have asserted, instruction in job-related reading does not necessarily lead to narrow, limited, focused skill improvements

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(Kazemak, 1991). Rather, properly designed job-related reading training can improve both special literacy and general literacy.

FLIT Delivery System Studies

A problem of both general and job-related reading programs like FLIT is that they add to the time the student spends in training and that counts against productivity. To determine if significant improvements might be made in workplace and general literacy skills without adding much to the training time, two special studies were conducted. In the *extended training day* study, the FLIT training-related reading instructional materials were offered after duty hours for students in motor transport operator's and wheeled-vehicle repairman's job training. In the *integrated training day* project, FLIT clerical materials were adapted for students in the Army's supplyman's course. This course had earlier been system engineered to make it more functionally related to work requirements, and it was a modularized, self-paced course specially designed to accommodate lower aptitude personnel (Hungerland & Taylor, 1975). All students in the literacy component of the program received instruction in job-related reading in one of three two-hour time periods scheduled daily. The total duration of the reading program was tied to the time it took the student to complete the self-paced supplyman's course, five to six weeks in most cases. Hence, the usual FLIT six-week add-on to the training was accommodated in five or six weeks of job technical training, a reduction by half from a dozen weeks for both the FLIT reading program plus technical training.

A summary of the pretest and posttest scores for the extended day and fully integrated literacy training program is given in Figure 16, Appendix B. In both cases, considerable improvements were made in job-related reading; furthermore, improvements were found in general literacy.

The foregoing suggests that, at least within the Army context of the time, it was feasible to integrate job skills training and reading training within the same program without adding to the overall training time of traditional lockstep job skills training programs. It was also possible to make significant improvements in both job technical knowledge and reading skills during this integrated program. Since this approach deletes the need for a separate six-week literacy program, it is a more cost-effective way to provide literacy training.

FLIT Extrapolations

Additional applications of FLIT concepts and methods were made in a project called Functional Literacy for the National Guard (FLING) (see Fox, McGuire, Joyner, & Funk, 1976) and in the Job Oriented Reading Project (JORP), sponsored by the Air Force (Huff, Sticht, Joyner, Groff, & Burkett, 1977). Pretest and posttest data on job reading task tests are presented for both projects in Figure 16, Appendix B, along with pretest and posttest scores on a general literacy test for the Air Force JORP. (FLING did not measure general literacy gains).

Comparison to Other Programs

The data from the FLIT project permit an evaluation of the job-related versus general literacy approaches for improving job reading performance.

This is the purpose of many workplace literacy programs, both in and outside the military.

Reading from the top of Figure 16, Appendix B, the data show how well Army vehicle mechanics trainees who received no literacy training performed before the mechanics course on the job-related reading task tests and on a general reading test. These students received no literacy training between pretests and posttests. However, the training program itself required a considerable amount of reading. The data show that with just the normal reading of the training program, the students made gains in both general and job-related reading skills. In short, vocational training that requires considerable reading can lead to literacy gains.

The next two programs in Figure 16, Appendix B, are both general literacy programs that were ongoing in the Air Force and Army at the time of the FLIT project. The 13-week Air Force program used the Job Corps competency-based, programmed materials. The Army program was one of the three- to six-week general literacy programs conducted by the Army. The data indicate that neither the Air Force nor the Army general literacy programs made much improvement in job-related reading.

At the six sites where FLIT was implemented, improvements were greatest in job-related reading. These were greater than the improvements shown in no literacy training and as good in general literacy improvement as the Army general literacy programs. The replication of the FLIT results at five operational sites across the nation beyond the Fort Ord site where the FLIT program was developed is a strong indicator of the generalizability of the job-related literacy training approach.

The FLIT extended and integrated training days, and the FLING and JORP programs were all consistent with the six FLIT implementation sites in greatly improving job-related reading. Even the more highly skilled readers in the Air Force JORP showed much improvement, indicating that the effects of job-related reading training are not limited to the very lowest ability readers.

Overall, data from the FLIT project seriously challenged short general literacy programs for improving workplace literacy. For this reason, the General Accounting Office (GAO) recommended to Congress that literacy training in the military be made relevant to the person's job (General Accounting Office, 1977). By the time this recommendation was made, however, the FLIT job-related literacy training had all but disappeared. This was due, in part, to the fact that the Army contracted with civilian educators to provide literacy training and had no provision for training civilian educators in job-related literacy training methods. Also, differences between Army education and Army technical training management contributed to the demise of the job-related approach. The Army education management was concerned that, if job-related reading were incorporated widely into all literacy training, then perhaps the education budget would be taken over by the Army technical training organization. This intra-organizational conflict is explored in Anderson (1986).

Despite these organizational problems in the Army, the Navy moved to establish job-related literacy in the late 1970s, largely in response to the need to provide opportunities for minorities to move up in the organization. The major program emerging from this concern was the JOBS program.

THE NAVY'S JOBS PROGRAM

The Navy's Job-Oriented Basic Skills (JOBS) program was initiated as a means of overcoming predicted shortfalls in high-quality personnel, that is, those with high school diplomas and aptitude scores above the 50th percentile. In addition, there was interest in offering minority groups, disproportionately employed in lower level Navy jobs, upward mobility through access to a broader range of occupations demanding higher aptitudes (Baker & Hamovitch, 1983). Following a review of the FLIT and JORP projects and studies of the effects of reading skills on Navy technical training performance, it was judged "potentially beneficial for the Navy to develop a JOBS program, which would further expand upon the Army/Air Force concept of job-oriented basic/prerequisite skills training" (Baker & Hamovitch, 1983, p. 3).

The JOBS goal was to determine whether job-oriented or *prerequisite* skills training would enable lower aptitude seamen in general detail jobs to succeed in selected technical training programs for which they were previously not qualified.

JOBS Program and Its Approach

The JOBS program, which is still operational, allows recruits disqualified from technical schools, after serving time in general labor or recruit training, to apply to JOBS for technical training. Successfully attending the JOBS program for several weeks allows them to enroll in other technical training.

Like the early FLIT program, JOBS is an add-on to the training sequence. It is not integrated into technical training. JOBS concentrates on prerequisite skills and knowledge for technical training, and is not designed, as were FLIT materials and approaches, to reinforce or exercise existing skills or knowledge that was simply not well-developed or used by trainees. In addition to its focus on prerequisite skills, JOBS differs from FLIT, FLING, and JORP by including listening (note taking), study skills, and mathematics, along with instruction in reading.

The JOBS research and development team designed materials for four courses: propulsion engineering, operations, administrative/clerical, and electricity/electronics. The skills and knowledge that students should have before entering technical school were identified by examining training materials and interviewing faculty and students. The analysis focused on identifying skills and knowledge that were needed but not taught in the technical training programs.

To identify the needed skills and knowledge that candidates for JOBS already had, special paper-and-pencil tests were developed and administered. Qualified technical school recruits also took the prerequisite knowledge tests. It was thus possible to compare JOBS candidates' performance to the performance of fully qualified recruits to determine if the JOBS candidates were lacking in prerequisite knowledge for success in technical training. Through this pretesting, plus additional decisions by the project team (e.g., to include training in independent study skills), the content to be taught in each of the four courses was identified.

In addition, the JOBS team analyzed technical school tasks in a hierarchical manner. For example, when analyzing a task such as "use index in administrative/clerical publications," the development team would ask what would the student need to know to do that particular task. This led to a second level of skills and knowledge, and the team would again ask what the student would need to know. Through this hierarchical analysis, subskills, sub-subskills, and so on were identified.

However, at some point, the analysis stopped, and it was simply asserted that below that level, students would need a sixth-grade reading skill, as though all adult tasks could be reduced to prerequisite skills and knowledge learned by people who had completed the sixth grade (Harding, Mogford, Melching, & Showell, 1981, p. 8). This problem of matching the job analysis to entry knowledge is a problematic one and has made it difficult to implement a major instructional principle derivable from the developmental model: new knowledge should build on old knowledge (see Sticht et al., 1987, chapter 11 for one approach to the application of this principle).

Special pretests and posttests assessed learning in the four courses of JOBS training. Preliminary data for three courses showed increases of from 43% to 56%, indicating substantial improvement in prerequisite skills and knowledge.

Evaluation of the JOBS Program

The major objectives of the JOBS program were to provide access to and success in technical training for lower aptitude recruits and upward mobility for minorities. Data on these objectives were reported by Baker and Hamovitch (1983). Of the 1,500 JOBS graduates studied, 1,200 had gone on to technical training. When compared with a comparison group of personnel who qualified for technical training without needing JOBS training, the JOBS students were over 50% minority versus 20% for recruits who had qualified from the outset for technical school. This indicted the JOBS program was meeting its goal for upward mobility of minority seamen.

Regarding aptitude scores, the average AFQT score was around the 22nd percentile for the JOBS students, contrasted with the 52nd percentile for the comparison group. On education, however, the JOBS group was about 90% high school diploma graduates or higher, compared with only 70% of the comparison group. This was due, in part, to the fact that at the time recruits in Mental Category IV (10th—30th percentiles) were required to have high school diplomas to enlist, whereas higher aptitude recruits were not.

The primary evaluation data relate to attrition from JOBS, from technical training, and from the job (Baker & Hamovitch, 1983). Only 4% of JOBS students left the program; 21% of JOBS and 10% of the comparison group left technical school. After 33 months on the job, an additional 6.8% of JOBS students and 14.8% of the comparison group had left. Thus, though more of the comparison group got through technical school, where literacy skills are in high demand, their subsequent loss to the Navy was twice that of the JOBS graduates.

Overall, from technical school entry until after 33 months on the job, the JOBS students' attrition rate was 26% and that of the comparison group was 23%. While these data may signal a positive effect of the JOBS program, caution is required because the JOBS group had 20% more high school graduates, a factor that may suggest differences in persistence and character that can outweigh aptitude differences (Sticht, 1992, p. 66). Evidence for how well lower aptitude personnel might have done in technical school without the JOBS program was not presented. This is important because the evaluation report noted that entry standards were sometimes waived by as much as three points per ASVAB subtest, and "these waivered students, as a group, have a lower technical school attrition rate than do their ASVAB-qualified cohorts" (Baker & Hamovitch, 1983, p. 1).

Despite the limitations of the evaluation, the JOBS project is the only functional literacy project to accomplish follow-up on subsequent job performance. Given the serious workforce problems addressed and the generally positive indicators, it is notable that the JOBS program is currently operational, with support from Navy education and training management (which, in the Navy, is a unified organizational office).

THE ARMY'S JOB SKILLS EDUCATION PROGRAM (JSEP)

In March of 1977, the GAO analysts published an evaluation of basic skills training in the military services that was critical of the general literacy approach. The GAO recommended that the military services follow a functional, job-related approach like that of the FLIT project.

The JSEP Research and Development Phase

To develop job-related basic skills training, the U.S. Army Training and Doctrine Command first conducted a detailed analysis of the academic skills involved in the performance by soldiers in 94 of the largest jobs in the Army (Farr, 1986). This analysis included tasks that were common across all 94 jobs, as well as tasks unique to each job.

A major result of the analysis was a taxonomy of more than 200 prerequisite competencies for the jobs. Such competencies were considered to be not the content of the task per se, but rather the prior knowledge needed to permit the learning and/or performance of the task. The competencies were identified through reviews of soldier manuals and interviews with subject matter experts in the various jobs. Examples of the prerequisite competencies identified include (Anderson, 1986, Appendix H):

- Mathematics:
  - match numerals with word names and models
  - estimate measures of varying lengths, dimensions, or weights
  - estimate time in seconds, minutes, and hours
  - compute time using Greenwich Mean Time
  - multiply and divide whole numbers
- Reading:
  - recognize common words and their meanings
  - identify the correct meaning of a word from the context of a sentence
  - use the table of contents, indexes, system or subsystem heading, appendix, and glossary to locate information

By identifying the skills as prerequisite, the analysts decontextualized them from a particular job task context and represented them as generic, that is, applicable to many tasks, military or civilian. As the director of the JSEP project stated,

> It should be noted that while all of the skills in JSEP are job-related, only a few are *strictly* military (e.g., identifying grid coordinates on a military map). Although most of the lessons would be equally appropriate in civilian jobs, virtually all are presented in a military context—in other words, they have been thoroughly "greened" [note: this is a reference to the color of the Army uniform which is green. Soldiers are sometimes referred to as "green suiters."] (Farr, 1987, p. 7)

The JSEP instructional program consisted of three components (Farr, 1987, pp. 10-11):

- *Diagnostic Review.* This consisted of brief lessons in which soldiers tried to accomplish certain tasks. This component provided some feedback to stimulate recall if the soldier's main problem was that he or she had previously learned the skill, but had forgotten it. The aim was to permit soldiers to test themselves on skills they already had and to focus instruction on those competencies that were missing or very weak.
- *Skill Development.* This was the body of the program. It included modules on learning strategies, problem solving, reading comprehension, test taking, motivational skills (e.g., detecting moods and using several tactics to change them from negative to positive), and time management.
- *Tests.* The 182 instructional lessons all included prelesson and postlesson tests to determine if the competency being developed in the lesson had been learned.

Overall, the aim of the instructional program was to offer lean instruction in only those competencies from the list of 200 that were weak for a soldier. For this reason there was no set time limit, such as a six-week course. Soldiers could move through the program at their own pace and exit when they showed mastery of the various competencies.

Self-pacing was facilitated by instruction via computers (PLATO and MicroTICCIT) with some paper-and-pencil supplementary materials. The computer-based instruction (CBI) included complete data management systems for collecting student demographics, results of the diagnostic reviews and lessons attempted and completed, and lesson pretest and posttest results.

Evaluations of the JSEP

Several field trials of the JSEP were conducted in 1986 at Forts Rucker, Leonard Wood, Riley, and Sill to obtain formative evaluation data to be used in making modifications to the JSEP where needed. The tryouts involved small numbers of soldiers (10-43) at each site and included pretest and posttest data for a 300 item (180 math, 120 verbal) JSEP diagnostic test. At Fort Rucker, four groups of soldiers completed JSEP questionnaires and a 17 lesson sequence in a one-week trial. Pretest and posttest data on lessons were obtained to estimate the effectiveness in helping soldiers improve on the competency being taught.

At Forts Leonard Wood and Riley, a six-week trial was conducted. A JSEP General Questionnaire was administered that provided information about soldiers' attitudes about the conditions of learning by computer (e.g., was it easy, were reading or math skills more enjoyable because the lessons were job-related, etc.), the impact on the soldier (did the lessons help in the job), and how the JSEP met Army concerns (willingness to take more JSEP lessons during on-duty hours, during off-duty hours).

At Fort Sill soldiers were randomly assigned to experimental (n=32) and control (n=40) groups. The control group received pretests and posttests but no instruction.

General results on the attitude questionnaires were positive. Over three-quarters liked the computer-based instruction, but most preferred not to take lessons on their off-duty hours. Most (70-80%) thought the skills they learned in the JSEP would help them advance in the Army.

Pretest and posttest scores indicated that the lessons were effective in improving skills in the areas of particular competencies. For instance, on the lesson on job technical vocabulary, median scores at Fort Rucker were 47.8% on the pretest and 79.3% on the posttest (Farr, 1987, p. 15).

At Fort Sill, the experimental group made statistically significant improvements on a special practice test that assessed General Technical (GT) knowledge. Scores improved from 88 to 96. Since the GT is considered an aptitude composite (it is made up from subtests on the ASVAB), it is important that the JSEP improved scores on this test and indicates some generalization of the training to other tasks. GT scores for the control group also improved, but not to a statistically significant level. Generally, at Fort Sill, all pretest and posttest scores of the experimental group improved, while those of the control group did not.

On the 300-item pretests and posttests of math and verbal skills, significant improvements were made except at Fort Lewis. There the posttest scores were lower than the pretest by some 2%. At the other three sites, percentage increases ranged from 2% to 10% pretest to posttest (Farr, 1987, p. 57, Table 10).

In an independent evaluation, Hoffman (1989) reported the results from 220 soldiers who completed JSEP at 7 pilot test installations between January 19 and April 15, 1988. Data on learning outcomes were obtained for pretests and posttests at the lesson level, and on two tests of generalization: the General Aptitude Predictor (GAP) test, developed to resemble the GT and made-up of reading and mathematics subtests; and the TABE, a standardized test of literacy widely used in civilian basic skills programs.

On an average, 67% of soldiers pretested out of a given lesson. Across all verbal and quantitative lessons, soldiers did not need instruction 56% of the time. Soldiers needed and were successful in 35% of the lessons. They failed to complete lessons 9% of the time on average.

Regarding generalization, on the GAP tests, soldiers' scores improved by 3.1 points, about one third of the pretest standard deviation. Hoffman stated, "If the common rule of thumb were followed, that of requiring a gain of at least one-half of a standard deviation to demonstrate a meaningful effect, the GAP results would not appear to support JSEP as an intervention for GT skills" (1989, p. 4).

On the TABE, average pretest scores on reading increased 0.6 months, from grade level 10.2 to 10.8. On the TABE mathematics test, a gain of 16 months was made, from grade level 8.9 to 10.5. Before JSEP, 55% of the soldiers were reading on the TABE at the 10.0 grade level or above; after JSEP, 76% were above the 10.0 level. On the TABE mathematics pretest, 26% scored at the 10.0 grade level or better, while 60% were at this level on the posttests.

Hoffman (1989, p. 12) noted that a possible limitation of the study was that by the time JSEP was implemented, the Army and other military services had raised their standards for entry into the services. Consequently, there were few lower literacy ability soldiers to use in testing the JSEP. In this regard, even greater successes may have been achieved had lower literacy ability soldiers been exposed to JSEP in these evaluations.

A further limitation to the JSEP evaluations was that they included no assessments of soldiers' abilities to apply their newly improved basic skills to job-related reading or mathematics tasks. The GAP is not a job-related test, but rather an academically oriented test in which tasks are more school-like. Consequently, the extent to which the pretest and posttest improvement would permit soldiers to perform job-related basic skills tasks not directly taught was not assessed.

The "De-Greening" of JSEP for Civilian Use

In 1986, the Director of Adult Education in the U.S. Department of Education initiated activities to transfer the JSEP technology-based basic skills program from the military to civilian settings. This activity has resulted in the "de-greening" of the JSEP computer-based lessons and the use of JSEP in civilian settings (Philippi, 1989).

THE NAVY'S XFSP READING AND MATHEMATICS PROGRAMS

In early 1983, the Navy initiated another workplace literacy program (Sticht et al., 1986). The Experimental Functional Skills Programs (XFSP) in reading and mathematics were designed for Navy personnel already on the job who wanted to improve their skills for promotion to higher ranks and pay grades. The XFSP basic skills programs were thus oriented toward the general requirements that all Navy enlisted personnel must meet for achieving career progression.

The Conceptual Framework for the XFSP

The XFSP programs were developed following an adaptation of the model of the human cognitive system and its processes for extracting and representing information in the environment. The model for the XFSP reading program is presented in Figure 17, Appendix B. It has three major components, two inside the head and one outside the head. The inside components include the knowledge base—the long-term memory that contains all the person's information and knowledge—and the processing skills working memory that operates on information from long-term memory and the external environment. In concert, the components produce comprehension, communication, and thinking.

Figure 17, Appendix B, shows a person at Stage 4 of the developmental model of literacy—a person who has acquired both oracy and literacy information-processing skills. The literacy processes can recode written language into internal forms comparable to those used in oral language, and in addition can perform all those literacy tasks that are more than reading aloud or silently (i.e., they are not instances of writing as a second signaling system for speech). The tasks unique to literacy are those made possible by the properties of graphic displays: they are more or less permanent (thereby permitting study); they can be arrayed in space (thereby permitting construction of forms, signs, flow charts, graphs); and they use the properties of light (contrast, color) to guide attention and facilitate information processing.

According to the model, literacy tasks require (a) knowledge of the subject about which one is reading or writing (including mathematics knowledge), (b) processing skills for thinking about what to communicate or for comprehending what others communicate, and (c) graphic displays of information in the external environment to be processed for meaning. An important implication of this analysis is that it reveals that literacy, considered as the ability to use graphic symbol systems, can be enhanced by improving one's knowledge base, one's processing skills, or the design of the graphics displays with which the cognitive system must deal.

The XFSP for Reading

The XFSP reading program was based on the model described above and applied to the kinds of reading tasks that Navy personnel perform in their training and job settings. Students, instructors, and workers in ten Navy jobs were interviewed for information on the two types of reading tasks identified in the FLIT project: reading-to-do and reading-to-learn. The interviews revealed that reading-to-do and reading-to-learn were performed to about the same extent during training. On the job, however, reading-to-do comprised about three fourths of reading tasks. The processing skills needed in reading-to-do were less complex than in reading-to-learn. Reading-to-do required information location and extraction; reading-to-learn involved elaborate activities to merge new information with old knowledge.

Reading-to-learn was categorized into four processes: (a) reread or rehearse, in which learning was accomplished by repeating the material in some way; (b) question/problem solve, in which students asked themselves questions about the material or solved problems in textbooks; (c) relate/associate, in which the students transformed what they read into some other form (e.g., paraphrasing, making internal images, watching a movie and relating what they had read to the information in these iconic or realia information displays); and (d) focus-attention, in which studies focused on a limited aspect of the material (e.g., by highlighting with colored pens, underlining, summarizing).

The interviews also revealed the role of the knowledge base in performing job-related reading tasks. Close to 60% of job tasks that personnel needed to read about had been performed previously; in about half of the 325 reading tasks cited, some additional reading had already been done; and for two thirds of these tasks, prior knowledge from related reading helped personnel understand the new reading material (Sticht, Fox, Hauke, & Zapf, 1977).

The XFSP reading program was designed and developed to have a functional context for Navy personnel: it used contents and materials necessary to pass promotion tests and information-processing skills of use to them in reading to learn from career textbooks and to do a task in new positions.

The experimental program conducted to develop the XFSP reading program involved mostly mid-level literates, with reading scores at the sixth- to tenth-grade levels. These personnel had one or more years of service and thus a fair amount of knowledge about the Navy on which to base their learning in the program.

The XFSP reading instruction was designed to involve an integrated classroom in which teachers, books, computers, and peers worked to develop learning. Students attended the program for three hours a day, five days a week for three weeks, for a total of 45 hours of instructional time.

A special reading text, Navy Knowledge Base, was developed based on the model of the human cognitive system. It contained extracts and revisions from the technical manuals that personnel must read and learn from to pass promotion tests or perform high-level, supervisory duties. The contents contained information from the practice tests in the manual (i.e., material deemed important enough by the Navy to be practiced). A second book, Information Processing Skills: Reading Text, was modeled after the processing skills component of the human cognitive system model. It presented lessons and practice in the skills of reading-to-do and reading-to-learn, using the Navy Knowledge Base text as the source of the knowledge to be learned via the information-processing skills. The books were used to present a knowledge base and processing skills in a concrete form and to serve as teaching tools for talking about the internal knowledge base and processing skills. In this way, students were made aware of their own human cognitive processing system and how to use it for doing and learning by reading.

The focus of the instruction was on reading-to-learn. In this regard, the students were taught the PQ3R active reading strategy—preview, question, read, recode, and review.

The preview and question activities were before-reading tactics to form an idea about what was to be read and to mobilize prior knowledge about the topic. Then the material was read to gain an initial comprehension, and metacognitive procedures (such as noting whether or not understanding was taking place) were used to detect places where rereading was required. Then, recoding of information was emphasized, including the development of paraphrases, the construction of semantic maps, and the transformation of the maps into conventionalized displays such as outlines and tables. In some cases, students recoded information by drawing pictures about what they were reading, transforming expository texts into matrices or flow charts. Finally, the active reading tactic of reviewing what was read was taught as a means of reconstructing earlier learning to increase its retention.

Peers sometimes worked together to construct the tables or flow charts. Sometimes the teacher worked with the whole class, explaining and modeling the active reading strategy, for instance; sometimes the teacher tutored a student individually. Students worked at times on computer programs that incorporated Navy knowledge and reinforced the textbook materials.

The Evaluation System for the XFSP Reading Program

In the XFSP R&D work, a reading assessment system, considerably different from the nationally normed, standardized test in use by the Navy, was developed. It was called a system because it was more than just two or three forms of tests for pretesting and posttesting. Instead, it was a system that made it possible to configure many different forms of tests without having to re-norm them. Additionally, it permitted the generalization from Navy-related tests to adult literacy tests developed by the Comprehensive Adult Student Assessment System (CASAS). The latter system contains over 4,000 items of a functional nature and by assessing learners with a sample of 30 to 40 items, it is possible to know the probability that the person can perform any one of the 4,000 items. By placing the Navy-related tests on the same scale as the CASAS tests, it was possible to know the probability not only that the personnel could perform Navy-related tests but also each of the 4,000 items in the CASAS item bank.

Figure 18, Appendix B, provides an overview of the XFSP system and contrasts it to a typical general literacy program test, such as the TABE, the ABLE, and the Navy's Gates-MacGinitie Reading Test. It is worthwhile to note that traditional tests are grade- and school-oriented, with contents and tasks like those found in the elementary and secondary schools, while the XFSP system is Navy career-oriented with contents and tasks derived from Navy promotion manuals. Additionally, the traditional tests are normed on children, while the XFSP system is normed on adults.

The traditional tests, because they are designed to be used nationwide, cannot reflect any particular curriculum. Furthermore, the K-12 education system does not include specific reading instruction at individual grades. In contrast, the XFSP system was based on a specific, Navy-oriented curriculum similar to most job-linked literacy programs.

It is significant that traditional tests permit no explicitly stated generalizability beyond the test items to the performance of reading tasks not on the tests themselves. In contrast, the XFSP system used Item Response Theory (IRT) to scale test items. This made it possible to configure new, equivalent forms of tests with known difficulty without renorming the new tests. Furthermore, it was possible to state with some precision the probability that an examinee could perform items not included on the tests but which had been previously scaled on the same IRT scale.

In the Navy assessment system, the Navy items were placed on the same scale as the CASAS items, which made it possible to indicate the probability that a person receiving a certain XFSP reading test score could perform any of several thousand items in the CASAS item bank. Thus, unlike the traditional standardized, grade-school normed test, it was possible to generalize from the Navy-oriented tests to a broader domain of adult reading outside the specific work context.

Traditional standardized tests assume that reading is a content-free skill, and so no attempt is made to measure knowledge per se (though vocabulary knowledge may be assessed, but usually under the rubric of vocabulary skill). The Navy tests, on the other hand, were based on the model of the human cognitive system that indicates that knowledge is necessary for improving reading comprehension in some domain. To get an idea of the extent to which content-related knowledge is related to reading comprehension, the R&D team developed a series of readability formulas using Navy materials. The readability formulas were constructed to estimate the general reading grade level on the Gates-MacGinitie Reading Test needed to score at the 70% correct comprehension level on multiple-choice tests (this is the typical criterion for developing readability formulas in the schools). In this case, separate readability formulas were developed for groups of Navy recruits having very little background knowledge about the Navy to those having a great deal of such knowledge.

Figure 19, Appendix B, presents the effects of prior content knowledge on the general level of reading needed to reach 70% correct on reading comprehension of Navy materials. As indicated, the least knowledgeable recruits required 11th-grade reading levels to achieve the 70% comprehension level. This is the same as determined by the use of the Flesch-Kincaid readability formula, which was developed without regard to content-related knowledge on the part of the readers. The readers most knowledgeable about the Navy were calculated to need only 6th-grade general reading skills to reach the 70% comprehension level. This demonstrates that content-related knowledge can substitute for as many as five years of general skill and confirms the role of knowledge in reading comprehension as postulated by the human cognitive system model.

Given the importance of Navy-related knowledge in improving reading comprehension, the Navy test battery included a measure of Navy knowledge to assess growth in the XFSP program. The Navy battery also measured growth in two other broad categories of information processing: reading-to-do and reading-to-learn.

In the Navy test battery, it was possible to compare a person's performance on the knowledge test to his or her performance in answering questions based on reading a passage containing the needed information. This made it possible to determine how well the person could increment her or his store of knowledge about a topic or task using external memory stores (documents, books, manuals).

Evaluation Results

In the XFSP R&D, a number of different types of assessment methods were used to infer growth in workplace literacy competence. In a small study, a group of Navy students in an XFSP reading program were compared to a group of Navy students in a general reading program that was also 45 hours in duration. Both groups took pretests and posttests on the Navy Knowledge Test and the Navy Functional Skills tests of reading-to-do and reading-to-learn. Even in just this brief program, the job-related reading approach produced greater improvements in both Navy knowledge and information-processing skills than did the general literacy program. This is consistent with the military research on FLIT, FLING, and JORP.

In addition to the assessment test battery discussed above, the growth in competence was also assessed by participant ratings as to whether they "...felt better about their reading skills after completing the course" (43% strongly agreed, 29% agreed, and 28% were undecided); and whether "the content and activities covered in the course should help me in my Navy career" (71% strongly agreed, 29% agreed).

Portfolios of work in the program were also kept and examined by the teacher to determine growth in competence. The portfolio included copies of analytical tasks such as constructing matrices or flow charts. In the classroom, participants discussed and critiqued their matrices, flow charts, or drawings.

The Navy XFSP reading test illustrates an attempt to develop job-related assessment tools that capture both the content knowledge and information-processing skills that make up job-related literacy competence, while incorporating the new psychometric methods that permit the economical development of multiple forms of tests and the drawing of fairly precise generalizations about the person's ability to perform tasks not included within a particular test battery. In addition to drawing on the newer psychometric methods, the Navy XFSP reading test drew on the new understandings from the cognitive sciences regarding the role of domain knowledge in literacy and new understandings of the information processing involved in reading-to-do and reading-to-learn in both work settings and training programs.

A major conclusion to be drawn is that assessment of competence is not a totally objective, empirically derived activity. Rather, it will reflect the assessor's knowledge and understanding of measurement theory and current psychometric practices, theoretical understanding of what makes up competence in literacy, and an empirically determined understanding of how literacy is applied in different contexts including the workplace.

The XSFP for Mathematics

The XFSP program of mathematics instruction was also developed to prepare U.S. Navy enlisted personnel to move upwards through the ranks. As noted above, Navy personnel must pass a series of examinations to be promoted through the pay grades. To prepare for these examinations, the Navy provides a series of Navy rate training manuals. For the mathematics program, these various manuals were analyzed to identify the types of tasks that personnel would have to learn that required the application of mathematics knowledge. The Navy rate training manuals were used to develop a text called Mathematics for Navy Career Progression that included Navy tasks that require the use of mathematics for their performance. These tasks were grouped under three headings: Mathematics and Financial Resources, Mathematics and Material Resources, and Mathematics and Human Resources.

These categories represent the areas of supervision and management into which all Navy personnel would progress as they move up the ranks. By performing such tasks in the mathematics class, it was anticipated that personnel would learn how to apply mathematics to Navy tasks.

In pilot studies it was found that many Navy personnel were weak in reading comprehension strategies; they frequently failed in performing tasks more because of comprehension problems than because of lack of mathematics skills. It was also found that many did not know how to make notes about what they were reading in order to keep track of data extracted from tables, how to arrange the data to compute accurately, or how to communicate their computations in bar graphs and other types of figures.

Based on the pilot studies, it was decided to teach mathematics using the 3 Cs: comprehension, computation, and communication (see Figure 20, Appendix B). In this approach, personnel were taught an active reading strategy; computational operations and a mathematics knowledge base; and the importance of and skills for communicating the results of their work to others, including those whom they supervised and those who supervised them. It should be noted in the foregoing that there are three content areas that have been integrated: Navy supervisory and management content, reading strategies for comprehending and learning, and mathematics knowledge. This reflects the fact that in real life, job tasks include an admixture of information-processing skills.

The Mathematics Knowledge Base

The XFSP approach to mathematics instruction was based on informal classroom research that indicated that learners frequently did not know what they knew about mathematics. That is, they had no organized way of referring to what they had learned in mathematics up to the ninth-grade level or so. The mathematics knowledge base helped the students to see at a glance what they knew or had to learn in the field of mathematics in order to perform the job-related mathematics tasks in their occupational fields.

Figure 20 in Appendix B shows that there is really not a great deal to learn about mathematics in order to be able to function quite well in most jobs. There are only five chunks of knowledge that must be mastered. Students need to know how to perform the four operations using one of five types of numbers and working with ten or so systems of measurement. It is important to note that, in a work setting or other real world setting outside of school, people rarely compute numbers for the fun of it. They almost always compute numbers with one of the measurement systems given in the mathematics knowledge base, and they frequently have to use percentages, ratios, and proportions, which are numbers derived from relationships among numbers. Finally, they have to know some simple statistical concepts such as averages, medians, and range, and they will have to comprehend and present information in tables and graphs.

Instructional Approach

The instructional program in mathematics was designed to involve teachers, peer teams, textbooks, and computers. The students worked with two books, Navy Knowledge Base and Information Processing Skills, which instructed by using the 3 Cs and presented tasks to be accomplished (e.g., look-up data such as pay rates in the knowledge base, perform computations using the data, and then prepare lists, tables, or figures to communicate to others). Information Processing Skills contained an extensive section of decontextualized drill and practice exercises. Computer programs were also available, some commercially developed and others developed by the Navy R&D team.

The instructor at times worked through tasks with students, and, at times, teams of two or more students worked together to accomplish more complex tasks. Students were provided with calculators and instructed in their use. Much peer interaction and instruction occurred as those more familiar with the calculators and computers assisted those less familiar with these technologies.

Evaluation of the Navy Functional Mathematics Program

To evaluate the outcomes of the job-related mathematics course, a general mathematics test and a Navy job-related mathematics test were administered as pretests and posttests to eleven students in the last class of the experimental program. This was the only class for whom the entire program was available due to the time limits of the research and development project.

On the general mathematics test, students gained 20 months. On the Navy mathematics test, which was not scaled in grade levels, students gained 12.7% in computation skills (decontextualized mathematics problems including adding, subtracting, multiplying, and dividing whole numbers, fractions, decimals, percentages). More importantly, they went from a pretest score of 23.6% correct to 40.9% correct, for a gain of 17.3% on the performance of Navy mathematics tasks.

Thus, as with job-related reading programs, the findings suggest that job-related mathematics education can improve both job-related mathematics task performance and general mathematics skills. In the 45-hour mathematics course, students also improved about three months on the XFSP Navy job-related reading test.

While these data using Navy job-linked mathematics and reading tests suggest that the integration of Navy knowledge, reading strategies' instruction, and mathematics instruction may have paid off in all three areas, the very small number of students suggests the need for caution in accepting these results as conclusive.

CONCLUSIONS AND IMPLICATIONS FOR POLICY AND PRACTICE

The military's experience in literacy education clearly indicates that it has not been possible to take very low-level literates and develop them into high-level literates in up to several hundred hours of instruction. This is because, to a very large extent, becoming highly literate means that one must develop the broad bodies of knowledge discussed in the model of the human cognitive system. This requires many thousands of hours of wide-ranging reading and learning both in and out of school, as is accomplished by good students in the twelve years of primary and secondary education. To date, no research has been found in the military (or anywhere else, for that matter) that shows this type of extensive and intensive education for less literate adults.

Because of the immensity of time needed to develop broad bodies of knowledge, the military's emphasis upon job-related reading (in World War II and the FLIT, JOBS, JSEP, and XFSP projects) represents an effective means of accomplishing a significant growth in literacy in a circumscribed domain of knowledge. The research clearly indicates that the job-related approach produces faster development in job-related reading than does the general literacy approach. Furthermore, the research indicates that job-related reading may result in as much improvement in general literacy as typically occurs in general literacy programs.

The research reviewed above shows that most of the words in job reading materials are general literacy words, thus suggesting one mechanism for the improvement in general reading from reading job materials. Recognition skills for general literacy words are likely to get more practice than job-related word recognition skills in bodies of expository materials in the job field. Additionally, of course, sentence structure, paragraph structure (e.g., main idea with supporting ideas), and other frequent discourse types and document formats are engaged while reading within a job field. The data obtained with the generalized Job-Related Reading Task Tests in the FLIT program indicate that job-related reading may generalize from one job field to another.

All of the foregoing indicates that workplace literacy programs can, if designed properly, offer a good first step in developing adult literacy skills. They can produce fairly rapid growth in the immediate skills needed for work. But there will be a need for additional opportunities for continued education if the depth of knowledge developed within the domain of the world of work is to grow into the breadth of knowledge needed for adults to move easily from one job to another within a given career field, to change career fields across the lifespan, and to meet the needs of home, community, and nation in a world presenting an increasingly complex information environment.

Properly designing a good workplace literacy program will generally entail setting standards for entry into and completion of the program, as well as for developing the curriculum. This review indicates that there are two general approaches for identifying the literacy or other cognitive skills requirements of work that is even moderately complex.

The predictive validity approach relates literacy skills to measures of job proficiency. This requires methods for identifying what will be measured in the literacy assessments and what will be the criteria of job proficiency. Typically, literacy measures of competence will better predict measures of job-related literacy task performance than they will job sample tests or supervisor ratings. In fact, literacy and other cognitive assessments typically account for only 10% to 20% of the differences in the latter types of indicators of job performance.

The predictive validity approach can provide a useful indication of the degree of variation in job performance that is associated with variations in literacy levels. But, significantly, the military research reveals that there is no technical solution to establishing standards for literacy. There is no noticeable literacy gap to use as the obvious point to set standards. Rather, productivity on the job appears to be a continuous function of cognitive ability. Generally, the more a person knows and the better the person can reason with his or her knowledge, the more productive the person is likely to be. For this reason, setting standards is a judgmental process that must be performed by those involved. Another limitation of the predictive validity approach is that it does not provide curriculum materials needed for developing job-related literacy programs.

The task analysis approach to identifying literacy demands of jobs, as with the predictive validity approach, has no one methodology. To a large extent how one goes about conducting such an analysis will reflect one's understanding of work, literacy, and the aims and context of the development effort.

An important observation made during this review is that policymakers and management generally wish to express literacy requirements in an index number that establishes a general goal for the literacy program. Curriculum developers, on the other hand, need numerous examples of the types of tasks and materials used in performing literacy tasks on the job. An example is provided of a research project that combined the predictive validity and task analysis approaches to provide both a summary index number (e.g., grade level) that policymakers could use to set general levels of literacy to qualify for and complete literacy education, and a sample of materials that could be used by curriculum developers to prepare job-related literacy programs. The study suggests that such an approach is feasible, but a great deal more research is needed to evaluate its utility.

Finally, and perhaps most importantly, the conceptual framework and the review of the assessment of cognitive skills indicate that literacy is not some relatively simple addendum to human cognitive competence. Rather, both the conceptual framework and the empirical data suggest that one can be quite intelligent, well-developed in oral language, and possessed of high aptitudes for learning, even though illiterate or poorly literate. However, it is very unlikely that one can be highly literate and yet low in intelligence, poorly developed in language, and of low aptitude for learning.

The implication of this observation is that policymakers and program developers must recognize that to develop all adults to high levels of literacy means, essentially, that all adults must simultaneously be brought to high levels of intelligence, oral language, and learning ability. Fortunately, the significant correlations of all of these types of measures with years of education suggests that this might be accomplished through education. But, unfortunately, it is likely to take as extensive an education system for adults as presently exists for children.

Workforce and workplace literacy is a good place to start. It can help the adults involved gain access to work, promotions to better jobs, and opportunities for new careers. Even more importantly, it is also likely to help the schools do a better job by helping parents better care for their children and better prepare their children for school. Furthermore, adults who earn more provide a better tax base for supporting better schools, and they can provide resources for creating safer communities with recreational and other facilities where out-of-school learning can be better developed.

From this point of view, greater investments in adult workforce and workplace literacy, and provisions for lifelong learning might provide the fulcrum for leveraging the economic and educational reforms needed to move the nation toward unity with commitment to human dignity. It is a hypothesis worth testing.

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APPENDIX A: TABLES

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Table 1

Tests Used by the Military for Assessment of Cognitive Skills from World War I to the Present

Test	Historical Period Used	Dates Used	Content
Army Alpha	WWI	1918	Oral directions, arithmetical problems, practical judgment, synonyms-antonyms; disarranged sentences, number series, analogies, information.
Army Beta	WWI	1918	Maze, cube analysis, O-series, digit symbol, number checking, pictorial completion, geometrical construction.
Army General Classification Test (AGCT	WWII	1941-45	Verbal, arithmetic computation, arithmetic reasoning, pattern analysis.
Armed Forces Qualification Test (AFQT)	Post-WWII	1950-1952	Word knowledge, arithmetic reasoning, spatial relationships.
	Korean War/Vietnam War	1953-1973	Word knowledge, arithmetic reasoning, spatial perception, tool recognition.
Armed Services Vocational Aptitude Battery (ASVAB-AFQT)	All-Volunteer Force	1976-1980	Word knowledge, arithmetic reasoning, spatial relationships, mechanical comprehension.
		1980-1988	Word knowledge, arithmetic reasoning, paragraph comprehension, numerical operations.
		1988-Present	Word knowledge, paragraph comprehension, arithmetic reasoning, mathematics knowledge.

Note. From *Miltary Testing and Public Policy* (p. 13) by T. G. Sticht, 1992 & *Performance Assessment for the Workplace* (p. 50) by A. K. Wigdor and B. F. Green, Washington, DC: National Academy Press.

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Table 2

Subtests of the Army's Alpha and Beta Tests Used During World War I

ARMY ALPHA

Test for literates

Test 1 Following Oral Directions.

"When I say 'go,' make a cross in the first circle and also a figure 1 in the third circle."

⊕ ○ ① ○ ○ ○

Test 2 Arithmetical Problems

Ex: If it takes 6 men 3 days to dig a 180-foot drain, how many men are needed to dig it in half a day. Answer: (36)

Test 3 Practical Judgment

If a man made a million dollars, he ought to
[ ] Pay off the national debt
[x] Contribute to various worthy charities
[ ] Give it all to some poor man

Test 4 Synonyms-Antonyms

Samples: good-bad same - opposite
little-small same - opposite

Test 5 Disarranged Sentences

leg flies one have only true - false

Test 6 Number Series Completion

2 3 5 8 12 17 23 30

Test 7 Analogies

gun - shoots : : knife - run cuts hat bird

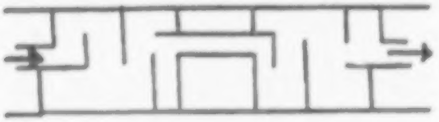
Test 8 Information

The Wyandotte is a kind of:
horse fowl cattle granite

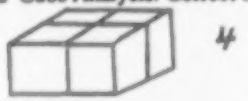
ARMY BETA

Test for illiterates and foreign language speakers.

Test 1 Maze. Credit for correct tracing of mazes.



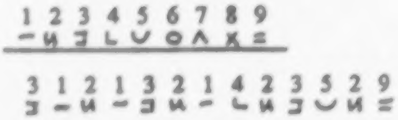
Test 2 Cube Analysis. Correct count of cubes.



Test 3 X - O Series. The series is to be carried out to the end of the line.

X 0 X 0 X O X O X O X O

Test 4 Digit Symbol. The appropriate symbol is to be written under each number.



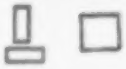
Test 5 Number Checking. Correct response indicated.

699310 . . . . X . . 699310
251004818 251004418

Test 6 Picture Completion.
Identify missing parts.

(mouth missing)

Test 7 Geometrical Construction. Construct a square (on right) out of figures on left.



Note. From "Psychological Examining in the United States Army," by R. M. Yerkes, 1921, in *Memoirs of the National Academy of Services, Vol. 15* (pp. 220-250). Washington, DC: National Academy of Services.

Table 3

Armed Forces Qualification Test (AFQT) Category Ranges and Percentile Distributions of World War II and 1980 Populations

AFQT Category	Percentile Score Range	World War II Reference' Populations	980 Youth Populations
I	93-10	8%	4%
II	65-92	28%	33%
III	31-64	34%	32%
IV	10-30	21%	24%
V	1-9	9%	7%

Note. From *Manpower for Military Occupations* (p. 101) by M. J. Eitelberg, 1988, Alexandria, VA: Human Resources Research Organization.

Table 4

Data for a Variety of Literacy and ASVAB Subtests Presented for Interpretation According to the Developmental Model of Literacy.

						Vocabulary Tests					Para-Graph Tests		ASVAB Special Knowledge Tests									Composites					
													Mathematics			Other Knowledge						Literacy Tests					
	Space Perceptions	Auding Paragraphs	Education	Attention to Detail	LAB Decode Total	LAB Vocab A&R	LAB Vocab R	G-M Vocab	ASVAB WK	N-D Vocab	G-M Paragraphs	N-D Paragraphs	Math-knowledge	Num. Operations	Arith. Reasoning	Electronics (EI)	General (GI)	Science (GS)	Automative (AI)	Shop (SI)	Mech. Comp. (MC)	LAB Total	G-M Total	N-D Total	BSA Total	GT	AFQT
						($\bar{x}$ = .35)					($\bar{x}$ = .35)		($\bar{x}$ = .43)									($\bar{x}$ = .39)					
Space Perception	1.00	.34	.06	.22	.31	.34	.35	.35	.38	.31	.41	.29	.41	.31	.46	.47	.38	.42	.42	.47	.56	.38	.40	.32	.41	.45	.64*
						($\bar{x}$ = .63)					($\bar{x}$ = .62)		($\bar{x}$ = .53)									($\bar{x}$ = .64)					
Auding Paragraphs	.34	1.00	.20	.20	.61	.67	.66	.70	.61	.53	.71	.53	.53	.47	.57	.57	.57	.58	.48	.51	.50	.82*	.74	.56	.62	.65	.63
						($\bar{x}$ = .72)					($\bar{x}$ = .71)		($\bar{x}$ = .56)									($\bar{x}$ = .73)					
Reading Paragraphs	.34	.73	.23	.30	.77	.72	.76	.78	.66	.62	.75	.66	.61	.59	.63	.60	.58	.63	.43	.49	.51	.91*	.80	.68	.77	.71	.68

Note: From *Literacy, Oracy, and Vocational Aptitude as Predictors of Attrition and Promotion in the Armed Services* (p. 58) by T. G. Sticht, L. R. Hooke, and J. S. Clayton, 1981, Alexandria, VA: Human Resources Research Organization.

*Part-whole correlations.

Table 5

Major Research and Development Projects to Develop Workplace Literacy Programs in the Military from World War II to the Present

Period	Event/Author	Acronym	Military Service	Focus
1943-1945	World War II Special Training Units (Goldberg, 1951)	STU	Army Navy	Army and Navy Life
1966-1975	Vietnam/All Volunteer Force, Functional Literacy Program (Sticht, 1975a,b)	FLIT	Army	Army Technical Training
1976-1985	All-Volunteer Force (Baker & Hamovitch, 1983)	JOBS	Navy	Navy Technical Training
1982-1987	All-Volunteer Force Job Skills Education Program (Farr, 1987)	JSEP	Army	Army Job Tasks
1983-1986	All-Volunteer Force Experimental Functional Skills Program in Reading & Mathematics (Sticht, 1991)	XFSP	Navy	Navy Career Progression

Note: From *Cast-Off Youth: Policy and Training Methods from the Military Experience* (p. 108) by T. G. Sticht, W. A. Armstrong, D. T. Hickey, & J. S. Caylor, 1987, New York: Praeger and *Design and Development of the Job Skills Education Program* by B. J. Farr, 1987, Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Table 6

Performance on the Module Pretest and Posttests for the FLIT Reading-to-Do Curriculum Strand

(1) Module	(2) N	(3) Passed Pretest[a]	(4) Passes Posttest	(5) Did Not Complete	(6) Training Effectiveness[b]
Table of Contents	710	19	67	14	83
Index	710	16	56	28	67
Tables and Graphs	710	20	53	27	66
Body of Manual	710	3	49	48	48
Procedural Directions	710	9	30	61	33

[a] Figures in columns 3,4,5, and 6 are in percentages.

[b] Column 4 divided by columns 4 & 5 equals training effectiveness.

Note: From "Developing Literacy and Learning Strategies in Organizational Settings" (p. 300) by T. G. Sticht in *Cognitive and Affective Learning Strategies*, edited by H. F. O'Neil, Jr. & C. D. Spielberger, 1979, New York: Academic Press.

APPENDIX B: FIGURES

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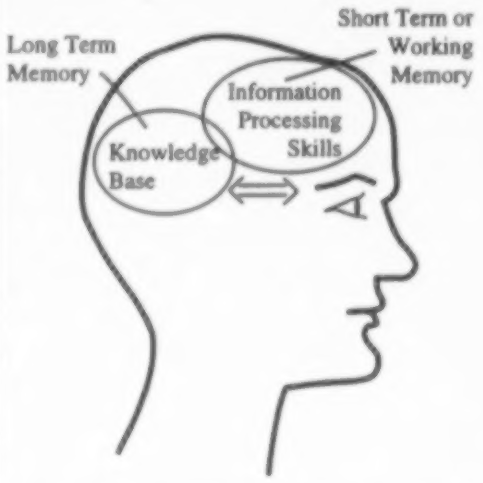


Simple Model of Human Cognitive System: Long Term Memory contains the knowledge base with language and various information processing knowledge. When thinking is taking place, information processing occurs in Short Term or Working Memory. The information processing skills operate on information in the knowledge base and information picked up from "knowledge bases outside the head," such as books, speech, by imporving or adding to information processing ability, or both.

Figure 1. Model of a human cognitive system used to interpret military studies on the assessment and educational development of literacy and other cognitive abilities.

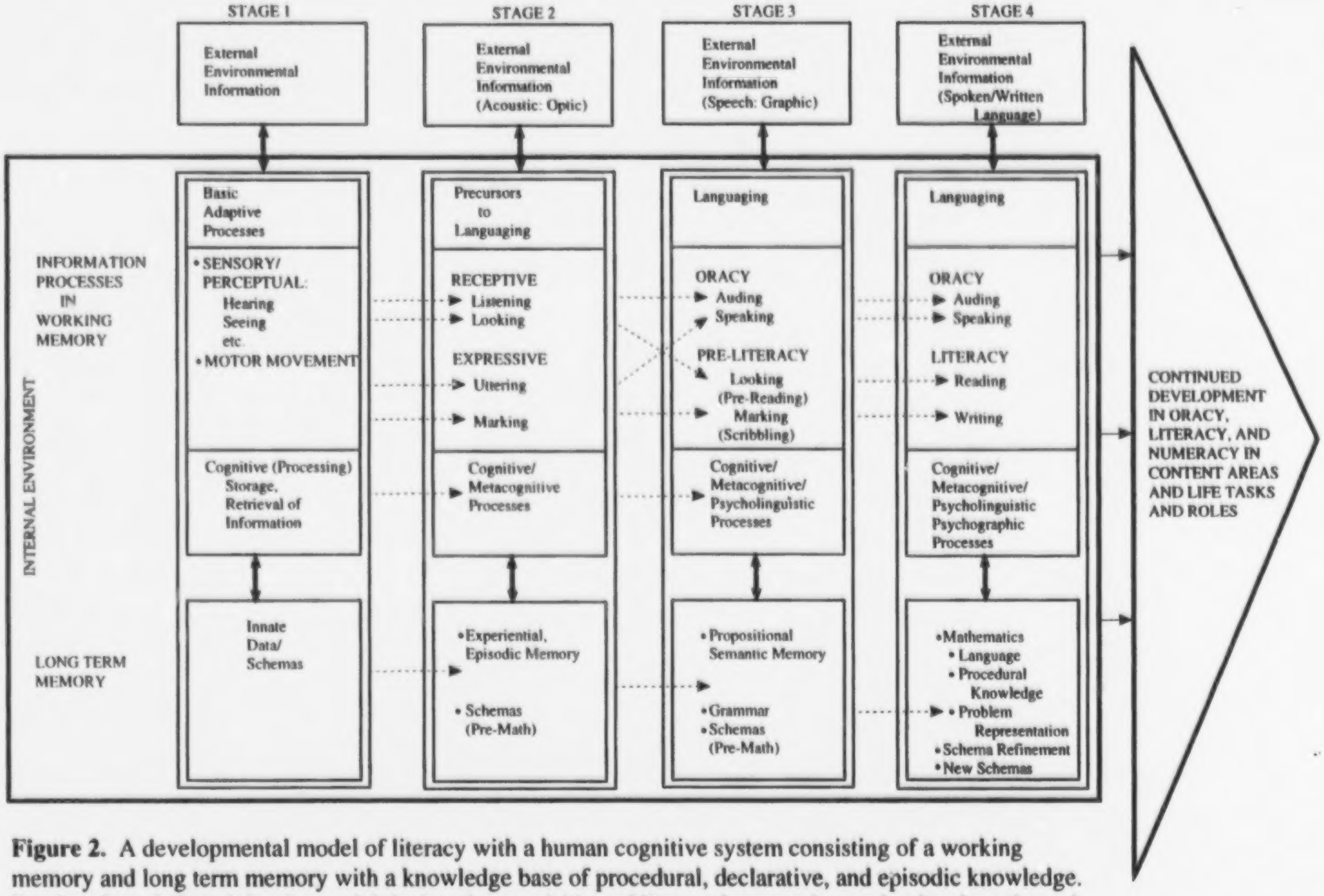
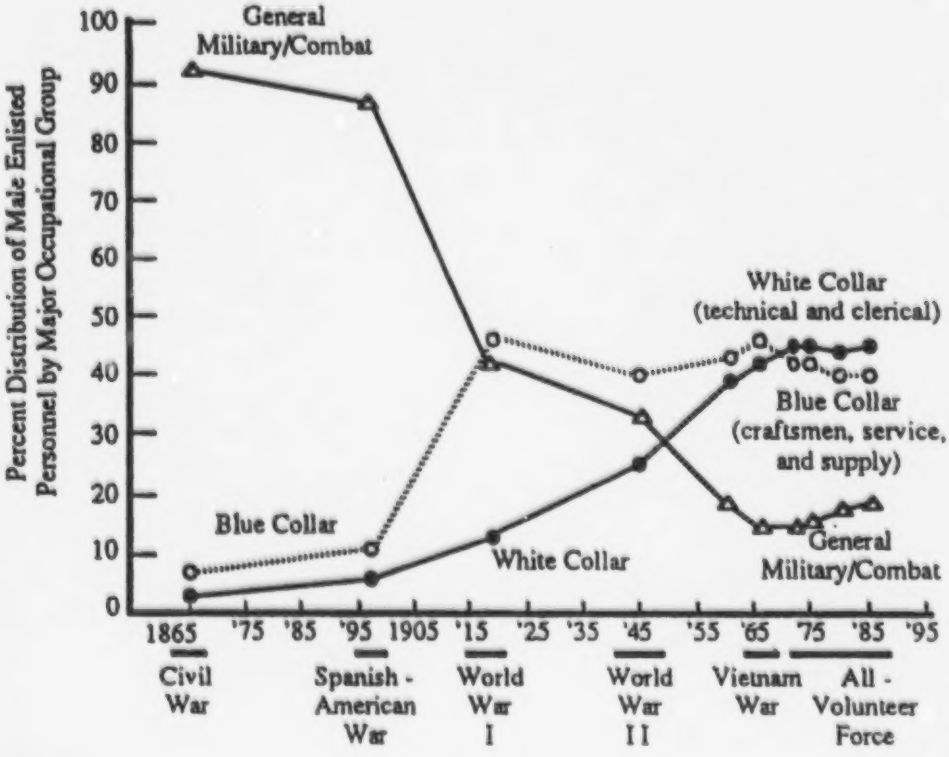
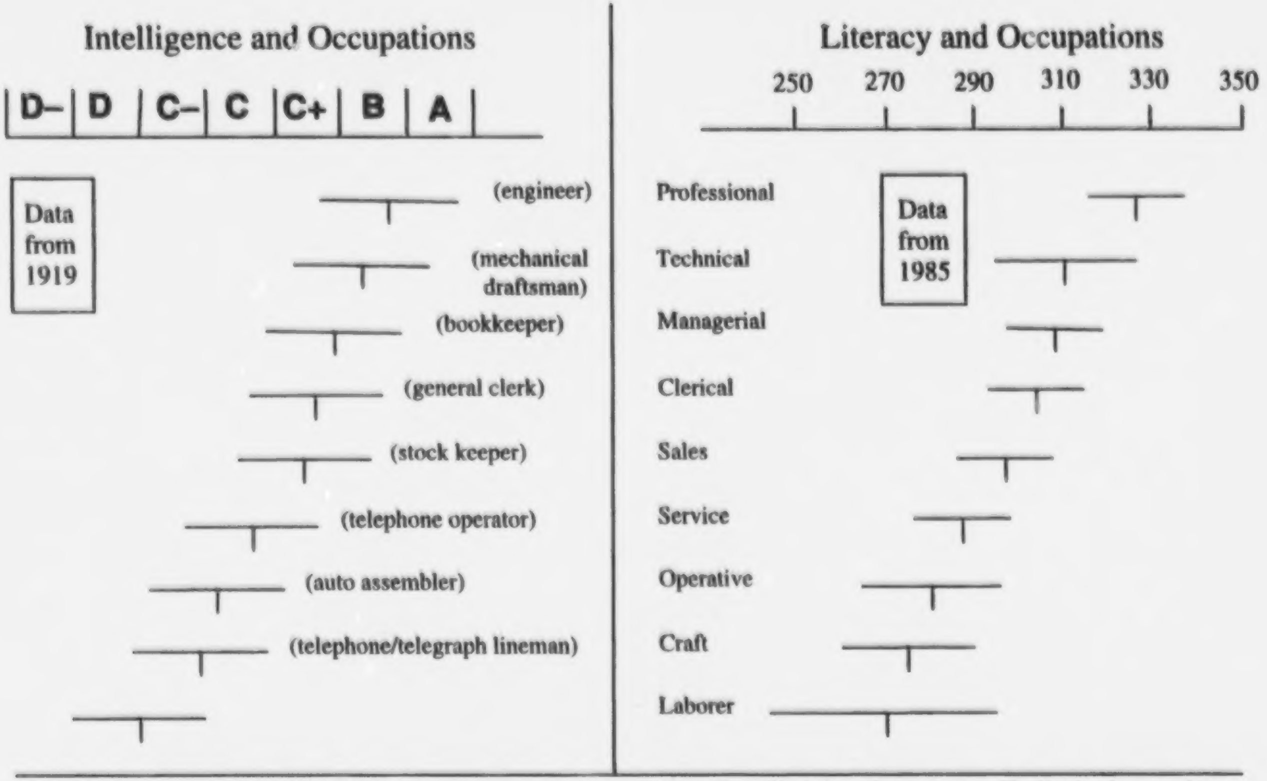

STAGE 1
STAGE 2
STAGE 3
STAGE 4
External Environmental Information
External Environmental Information (Acoustic: Optic)
External Environmental Information (Speech: Graphic)
External Environmental Information (Spoken/Written Language)
INTERNAL ENVIRONMENT
INFORMATION PROCESSES IN WORKING MEMORY
LONG TERM MEMORY
Basic Adaptive Processes
• SENSORY/ PERCEPTUAL: Hearing Seeing etc.
• MOTOR MOVEMENT
Cognitive (Processing) Storage, Retrieval of Information
Innate Data/ Schemas
Precursors to Languaging
RECEPTIVE
Listening
Looking
EXPRESSIVE
Uttering
Marking
Cognitive/ Metacognitive Processes
• Experiential, Episodic Memory
• Schemas (Pre-Math)
Languaging
ORACY
Auding
Speaking
PRE-LITERACY
Looking (Pre-Reading)
Marking (Scribbling)
Cognitive/ Metacognitive/ Psycholinguistic Processes
• Propositional Semantic Memory
• Grammar
• Schemas (Pre-Math)
Languaging
ORACY
Auding
Speaking
LITERACY
Reading
Writing
Cognitive/ Metacognitive/ Psycholinguistic Psychographic Processes
• Mathematics
• Language
• Procedural Knowledge
• Problem Representation
• Schema Refinement
• New Schemas
CONTINUED DEVELOPMENT IN ORACY, LITERACY, AND NUMERACY IN CONTENT AREAS AND LIFE TASKS AND ROLES

Figure 2. A developmental model of literacy with a human cognitive system consisting of a working memory and long term memory with a knowledge base of procedural, declarative, and episodic knowledge. Reading from left to right, the model depicts the acquisition of literacy by a newborn who develops through childhood to adulthood and acquires competence in literacy as an extension of other attention, language, and cognitive skills.



Note: From *Manpower for Military Occupations* (p. 11, Table 1) by M. J. Eitelberg, 1988, Alexandria, VA: Human Resources Research Organization.

Figure 3. Change in the occupational structure of the military force from the Civil War to the 1980s.



Note: From "Psychological Examining in the United States Army" by R. M. Yerkes, 1921, in *Memoirs of the National Academy of Science, Vol. 15* (pp. 872–829). Washington, DC: National Academy of Science.

Note: From *Workplace Competencies: The Need to Improve Literacy and Employment Readiness.* (p. 14, Table 1, Document Scale) by P. Barton and I. Kirsch, 1990, Washington, DC: U. S. Government Printing Office.

Figure 4. Occupational distributions of intelligence as measured by the Army Alpha and Beta Tests in World War I and literacy as measured by the National Assessment of Educational Progress's survey of young adult literacy skills in 1985.

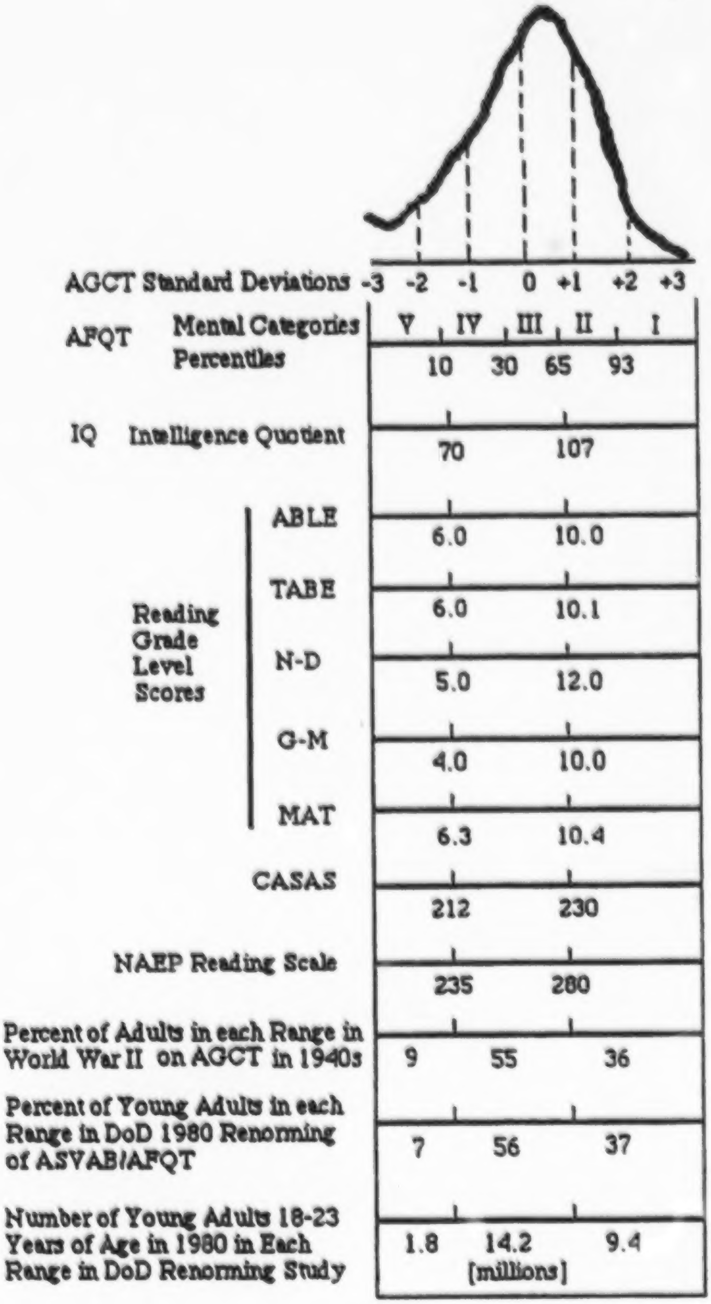


Figure 5. A composite figure showing the distribution of scores on the World War II Army General Classification Test administered to over 14 million men in relation to the AFQT, IQ scores, five standardized reading tests, scores on a version of the CASAS, and the NAEP Reading scale. Percentages of personnel in World War II and the 1980 renorming of the ASVAB are also given. The numbers of young adults in each range are for 25,408,795 18-23 year olds, represented by the Department of Defense (DoD) sample in the ASVAB renorming.

The figure is a composite of data taken from several studies. Reading scores and CASAS and NALS scores are all approximations.

The figure illustrates the similarity of the distribution of scores on various tests referred to as measures of intelligence, aptitude, or literacy.

AGCT=Army General Classification Test
AFQT= Armed Forces Qualification Test
IQ=Intelligence Quotient on the full scale of the Wechsler Adult Intelligence Scale.
ABLE=Adult Basic Learning Examination
TABE=Test of Adult Basic Education
N-D=The Nelson-Denny Test of Reading
G-M=The Gates-MacGinitie Reading Test
MAT=Metropolitan Achievement Test
CASAS=The Comprehensive Adult Student Assessment System
NAEP=National Assessment of Education Progress Reading Proficiency Scale administered to children in grades 4, 8, & 11 and to young adults 21 to 25 years old in 1985.

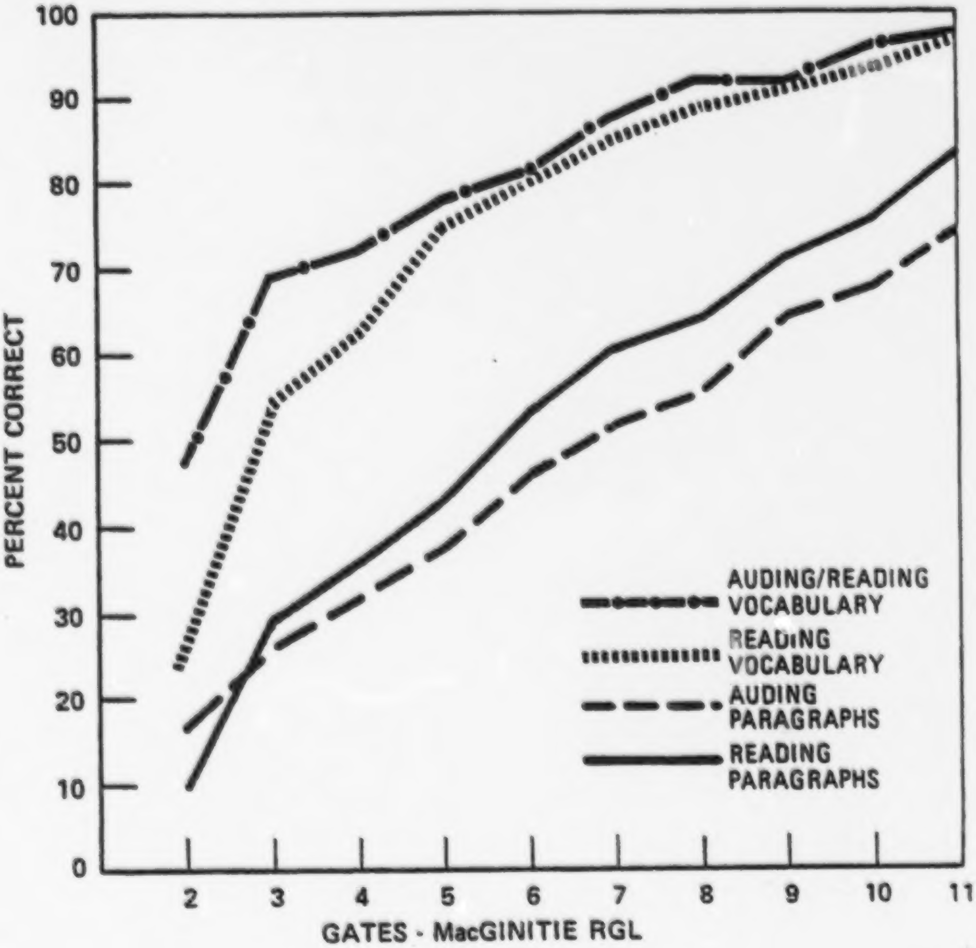


Figure 6. Auding (listening comprehension) and reading test performance for some 600 applicants for military service as a function of their reading grade level of ability on the Gates-MacGinitie reading test.

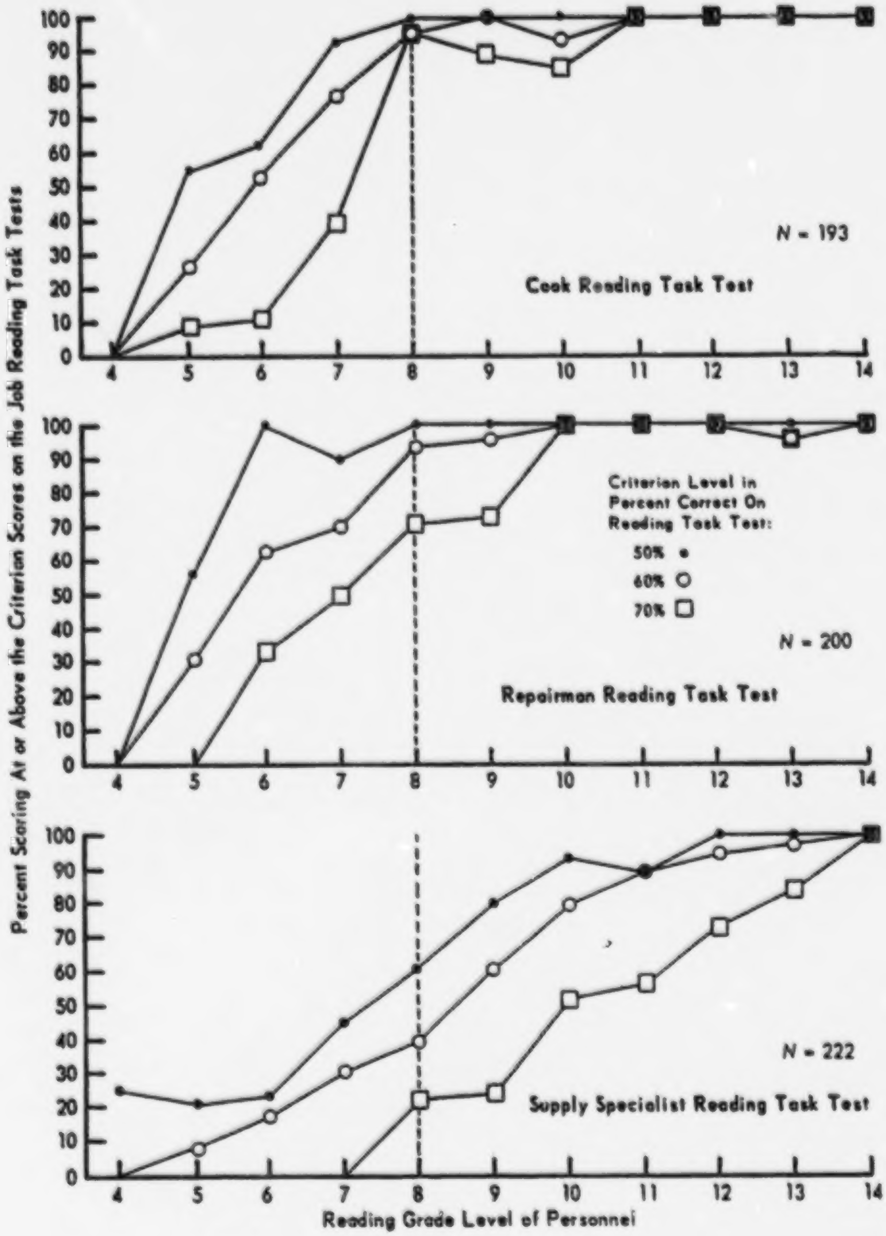


Figure 7. Percentage of Army personnel at each reading grade level reaching different criterion levels of performance on Job-Related Reading Task Tests (JRTT).

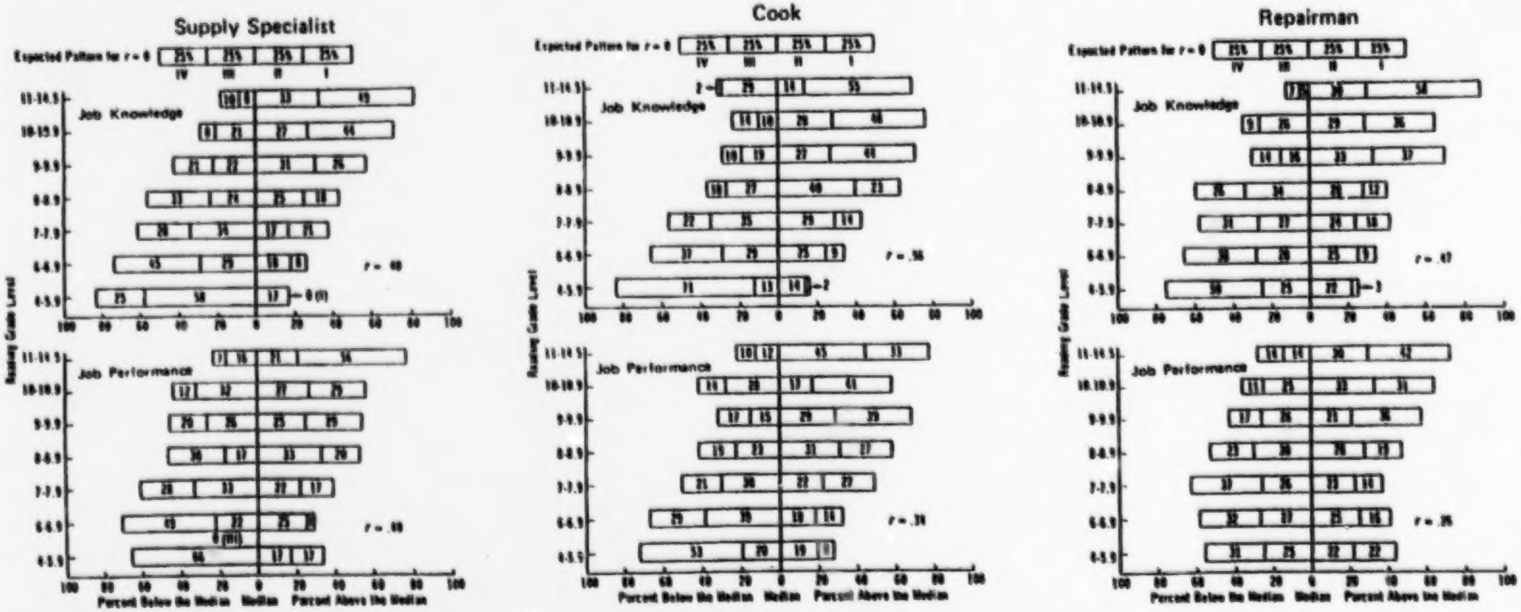


Figure 8. Quartile distributions for men reading at different reading grade levels of skill in three Army jobs. The figure shows that for cooks reading at the 4-5.9 grade level, 71 percent were in the bottom fourth of performers on the paper-and-pencil job knowledge tests while 53 percent were in the bottom fourth of those taking the hands-on, job performance tests. In general, the figure indicates that job performance, whether indexed by knowledge or job sample tests, improves as reading ability improves.

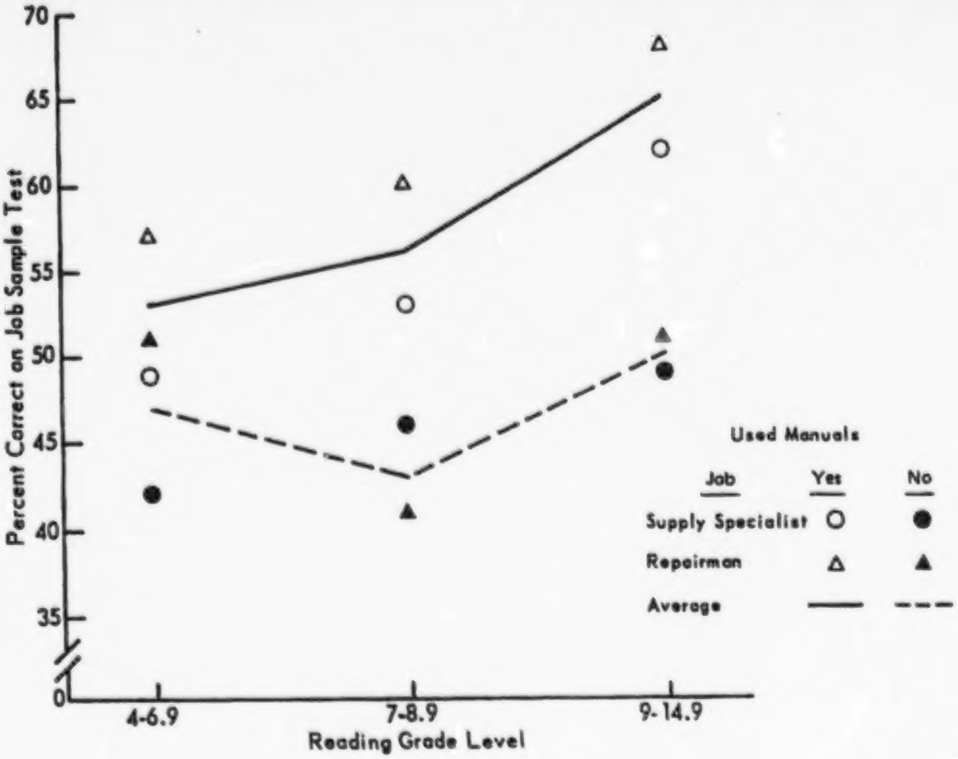


Figure 9. Job sample test performance of Army personnel as a function of their reading grade level and whether they did or did not use their technical manuals while performing the job sample tests.

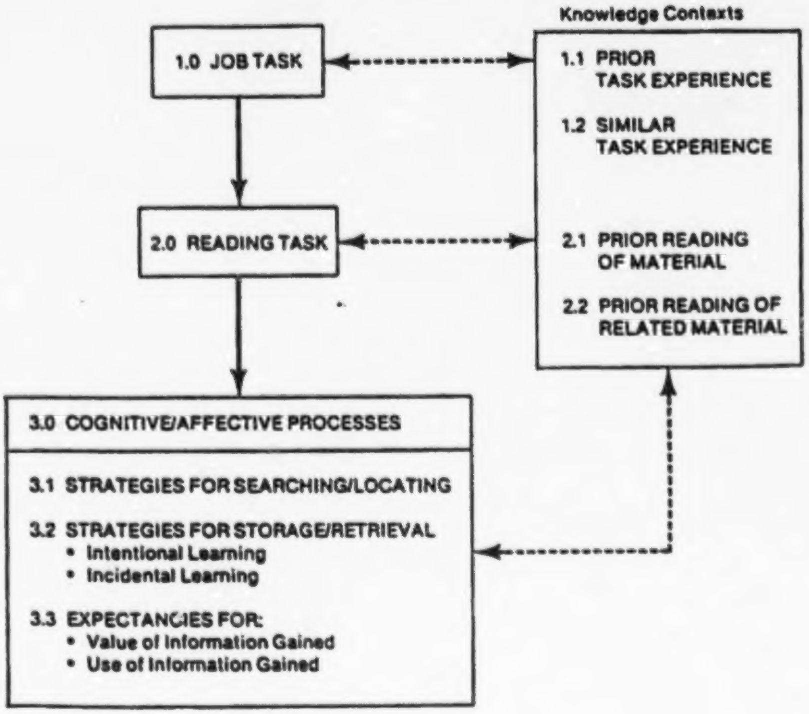

Knowledge Contexts
1.0 JOB TASK
1.1 PRIOR TASK EXPERIENCE
1.2 SIMILAR TASK EXPERIENCE
2.0 READING TASK
2.1 PRIOR READING OF MATERIAL
2.2 PRIOR READING OF RELATED MATERIAL
3.0 COGNITIVE/AFFECTIVE PROCESSES
3.1 STRATEGIES FOR SEARCHING/LOCATING
3.2 STRATEGIES FOR STORAGE/RETRIEVAL
• Intentional Learning
• Incidental Learning
3.3 EXPECTANCIES FOR:
• Value of Information Gained
• Use of Information Gained

Figure 10. Categories of information sought during interviews with Navy personnel to identify job-related reading tasks.

Anchor Chains. These are made of steel, and the size varies according to the size of the ship and its anchors. Chain comes in 15-fathom lengths (90 feet) called shots. A destroyer will have on eight-shot chain and one seven-shot chain. Shots are connected by detachable links; these links, and their adjacent links, are painted red, white or blue, to help the anchor detail know how much chain has run out. Each link of the next-to-last shot is painted yellow; the entire last shot is red. This is to warn that the bitter end of the chain is coming up. When an anchor is hoisted, the chain comes off the anchor windlass and into the chain locker.

Shot number	Color of Detachable Link	Number of Adjacent Links Painted White	Turns of Wire on Last White Links
1 (15 fathoms)	Red	1	1
2 (30 fathoms)	White	2	2
3 (45 fathoms)	Blue	3	3
4 (60 fathoms)	Red	4	4
5 (75 fathoms)	White	5	5
6 (90 fathoms)	Blue	6	6

NAVY READING TASK TEST/INVENTORY: RESULTS OF EXPLORATORY STUDY

Type of Task: Finding Facts in Texts and Tables (Form M, Item 11)

Question: How many fathoms of chain are in a 4 shot anchor chain?

Test Results: Percentage of personnel at each reading grade level who got the correct answer.

READING GRADE LEVEL	6	7	8	9	10	11	12	13	14	TOTAL
N	6	10	5	9	19	3	6	5	18	81
%	83	90	100	89	89	67	100	100	100	93

Inventory Results: Frequency with which this type of task is performed.

	1-3 times/ year	1 time/ month	2-3 times/ month	1+ times/ week	Daily	Not used
Electronics Technician		X				
Electrician's Mate				X		
Gunner's Mate						X
Boatswain's Mate		X				

Figure 11. Sample question from the Navy Reading Task Test (NRTT) that was used to construct a navy Reading Task Inventory. In taking the NRTT, personnel used the material on the left to answer the question on the right: How many fathoms of chain are in a 4 shot anchor chain? The test results show the percentage of personnel at each reading grade level who answered the question correctly (e.g., 83% of the 6 persons who read at the 6th-grade level answered the question correctly). The inventory results show the frequency that one person in each of the four jobs reported using the type of material on the left to answer job performance questionslike the one on the right.

Anchor Chains. These are made of steel, and the size varies according to the size of the ship and its anchors. Chain comes in 15-fathom lengths (90 feet) called shots. A destroyer will have on eight-shot chain and one seven-shot chain. Shots are connected by detachable links; these links, and their adjacent links, are painted red, white or blue, to help the anchor detain know haw much chain has run out. Each link of the next-to-last shot is painted yellow; the entire last shot is red. This is to warn that the bitter end of the chain is coming up. When an anchor is hoisted, the chain comes off the anchor windlass and into the chain locker.

Shot number	Color of Detachable Link	Number of Adjacent Links Painted White	Turns of Wire on Last White Links
1 (15 fathoms)	Red	1	1
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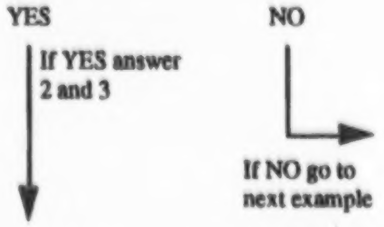
3 (45 fathoms)	Blue	3	3
4 (60 fathoms)	Red	4	4
5 (75 fathoms)	White	5	5
6 (90 fathoms)	Blue	6	6

Figure 12. Sample page from the Navy Reading Task Inventory (NRTI) that was used to identify job reading tasks. In using the NRTI, personnel used the material on the left to answer the questions on the right. Figure 11 shows the results of the use of the item illustrated. The inventory results show the frequency with which one person in each of the four jobs reported using the type of material on the left to look up factual information for use in accomplishing a job task.

(1) In your job would you ever have to perform reading tasks using material like this to look up facts?



(2) How frequently do you perform a reading task similar to this?

1	2	3	4	5
1-3 times/ year	1 time/ month	2-3 times/ month	1+ times/ week	Daily

(3) What might be the consequence of a reading error with this type of reading task?

1. No consequence.
2. I would be disciplined and some time would be wasted.
3. The job would have to be done over again and some time would be wasted.
4. The job would have to be done over and some materials would be wasted.
5. The job would have to be done over and some people would be inconvenienced.
6. Equipment would be damaged or lost.
7. I might be injured or other personnel might be injured.

NATIONAL CENTER ON ADULT LITERACY
B - [illegible]

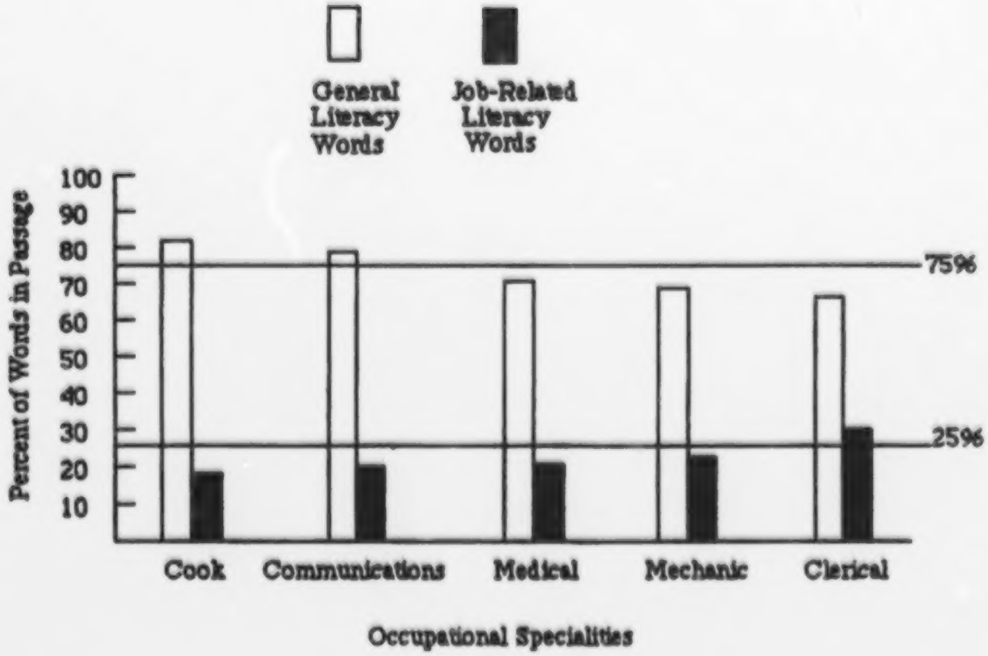


Figure 13. Percentage of words in technical manuals in five Army career fields that were on a list of general literacy words and those that were not on that list and were designated as job-related words.

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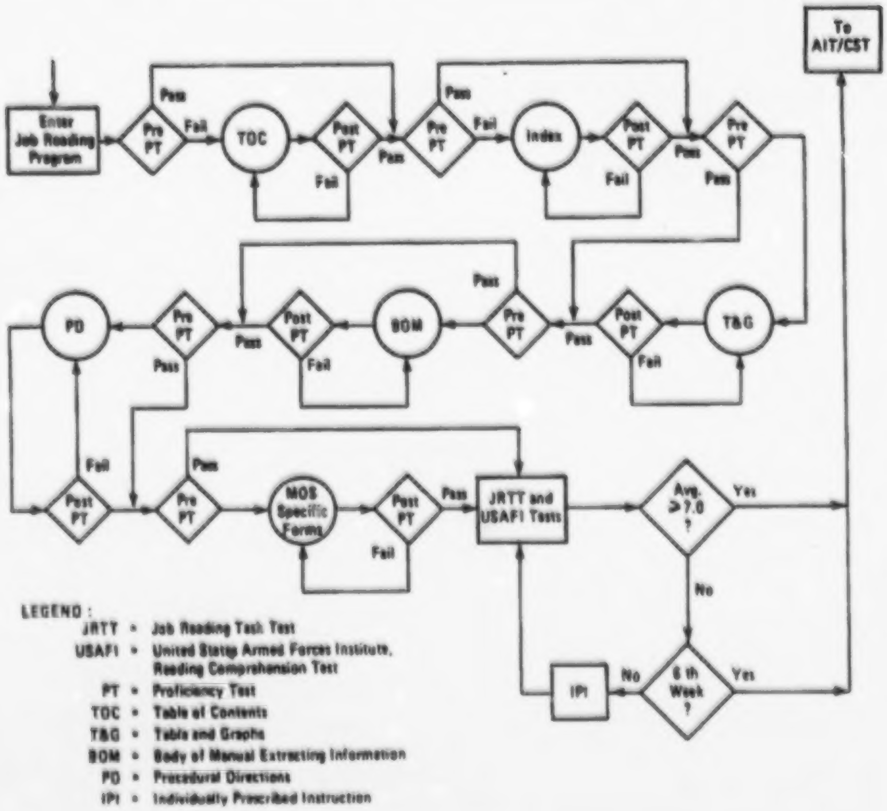


Figure 14. Instructional modules for the "reading-to-do" curriculum strand of the Army's experimental Functional Literacy (FLIT) program.

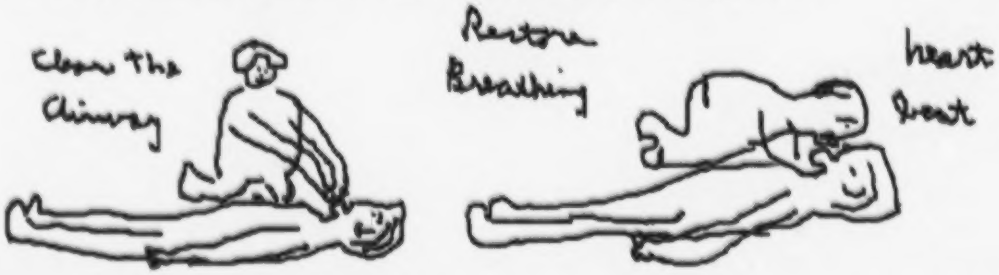
First Aid

Text Representation of Lifesaver Step 1

I combat or on the firld, doctors and medics cannot be every place to treat injuries as they happen. You may have to give fast emergency care to yourself or to someone else. Such emergency medical care before a doctor or medic can see the patient is called first aid. The most immediate first aid steps are the four basic lifesaver steps. follow these steps in order: (1) clear the airway and restore breathing and heartbeat, …(2), etc.

The first step must be done immediately. The injured person's life may depend on it. He cannot breathe if something blocks his mouth or throat. Take out anything from the mouth that does not belong there. If the person still cannot breathe, give him artificial respiration. The best method to use if you can is the mouth-to-mouth method.…

Picture representation of Lifesaver Step 1: 7th grade level reading student



Flow Chart Representation of Lifesaver Step 1: same student

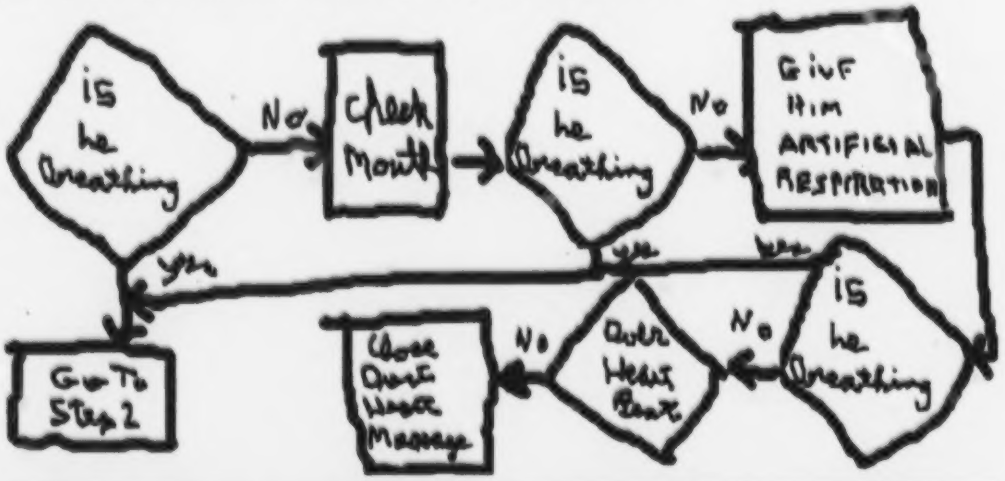


Figure 15. A representation transformation task from the reading-to-learn strand of the Army's experimental Functional Literacy (FLIT) program. In this task, learners first read the paragraph, then drew a picture representing the meaning of the paragraph. In a second transformation task, the paragraph was studied and converted into a flow chart representation. Learners then explained their flow chart using oral language. By performing multiple transformations of the textual material, the concepts in the passages were learned. Additionally, analytical skills and methods of constructing graphics tools for thought (pictures, flow charts, matrices) were learned as aids for reading-to-learn.

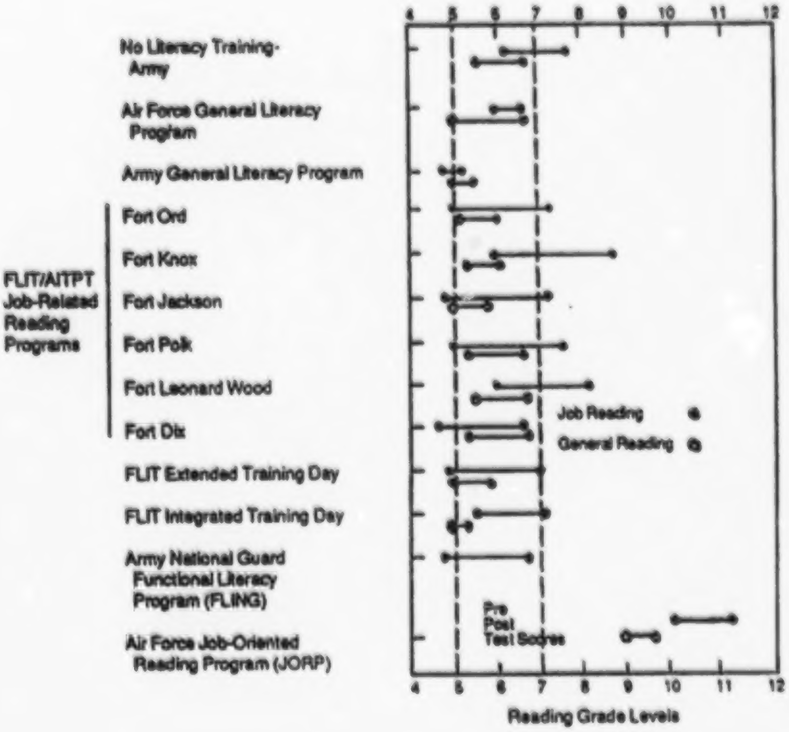


Figure 16. General and job-related reading test score improvements in the FLIT program and its derivatives.

Internal Environment ("inside the head")				External Environment ("outside the head")
Long term Memory		Working Memory		
Knowledge Base		Processing Skills		Information Displays
Pre-Linguistic ("world" knowledge)		Language		Speech
		Oral		Books
Grammar	<==>	Written	<==>	
Semantic Knowledge		Problem-Solving		"realia"
Organized Bodies of Knowledge "schema" job/work academics procedural knowledge		Self-Monitoring		
		Task-Specific Processes		

Figure 17. Human cognitive system model used as a heuristic for developing reading and mathethematics programs in the Navy's Experimental Functional Skills Program (XFSP).

Experimental Functional Skills Program
Reading Assessment System

Current System	New XSFP System
Elementary & secondary School-oriented	Navy Career Progression-Oriented
Normed on school children	Normed on adults
Based on NO curriculum	Based on Navy-related, Standardized curriculum
Reading Grade Level Scale	Rasch Item Scale of Reading Ability
Non-equivalent forms	Equivalent forms
Skills oriented	Scaled to be comparable to California Adult Student Assessment System (CASAS)
	Skills and Knowledge-oriented
	Reading to do Reading to learn Navy Knowledge

Figure 18. A comparison of the Navy's reading assessment system in place at the time of the initiation of the XFSP Reading program development project and the new assessment system developed in the XFSP project.

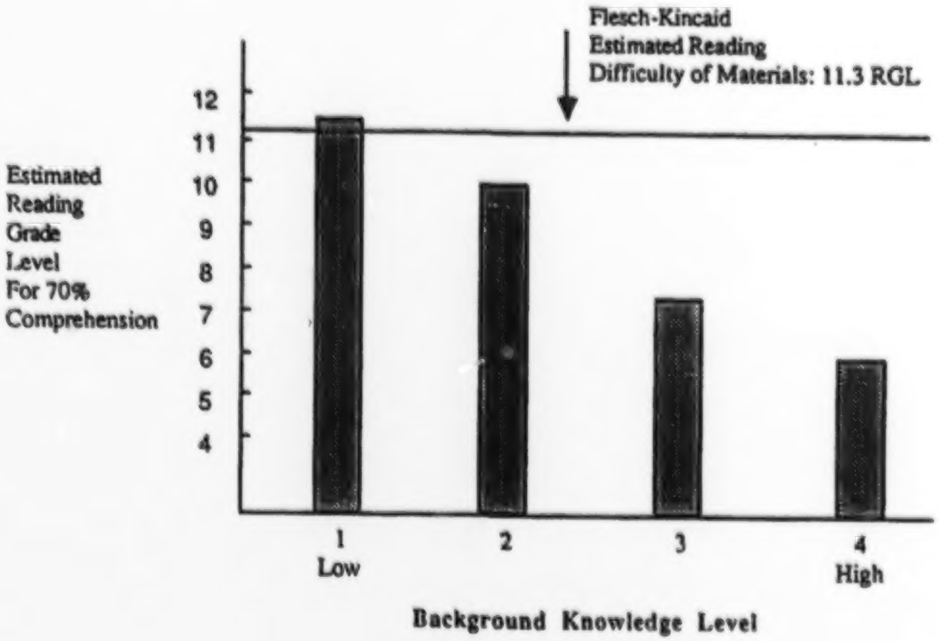


Figure 19. Estimates of general reading skill needed to reach 70 percent comprehension of Navy-related reading material using readability formulas developed for readers having low, medium, and high levels of prior knowledge about the Navy. The figure indicates that a person with low prior knowledge needs 11th-grade reading skills for 70 percent comprehension of Navy materials while a person with high prior knowledge about the Navy needs only 6th-grade reading skills for 70 percent comprehension of Navy materials.

The 3 Cs

1. Comprehend

- State what you are to do.
- Decide on the steps you should follow.
- Collect the necessary information.
- Decide what system of measurement to use.

2. Compute

- Decide what computation to do. This involves deciding on the operation to do, the types of numbers you need to use, the system of measurement, and whether to use statistics, tables, or graphs as part of the process.
- Do the computation.

3. Communicate

- Communicate the results to yourself and others in writing (completed forms; tables; graphs).

The Mathematics Knowledge Base

Basic Operations

Addition
Subtraction
Multiplication
Division

Types of Numbers

Whole Numbers
Fractions; Decimals
"Mixed"; Signed

Systems of Measurement

U.S. Standard Measures; Metric; Length; Area; Weight; Volume; Time; Temperature; Money

Statistics and Graphs

Count Distributions; Central Tendency; Variability; Bar, Line, and Circle Graphs

Relationships Between Numbers

Percentages; Ratios; Proportions

Note: From *Instructor's Guide for GOALS: Glencoe Occupational Adult Learning Series* (p. 6) by T. G. Sticht & B. A. MacDonald, 1993, Columbus, OH: Glencoe/Macmillan/McGraw-Hill School Publishing Company.

Figure 20. The "3 Cs" and "Mathematics Knowledge Base" used in developing the Navy's Experimental Functional Skills Program (XFSP) in mathematics.